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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

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Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*)

Forthcoming Events.

NOVEMBER 12.

Institute of Metals (Scottish Local Section):—Ordinary meeting at 39, Elmbank Crescent, Glasgow. "Nickel in the Non-Ferrous Foundry," Paper by A. C. Sturney, B.Sc., A.R.S.M.

NOVEMBER 13.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Some Factors in Fuel Economy," Paper by James Cunningham.

NOVEMBER 15.

Institute of Metals (Birmingham Local Section):—Ordinary meeting at Birmingham. Open discussion on standardisation.

NOVEMBER 27.

Institute of Metals (Birmingham Local Section):—Ordinary meeting at Birmingham. Paper by D. F. Campbell, M.A., A.R.S.M., on "Electric Furnace Developments."

Institute of British Foundrymen.

NOVEMBER 10:

Wales and Monmouth Branch:—Ordinary meeting at Newport. "Talk on Cylinder Iron," Paper by F. J. Coak.
Newcastle and District Branch (Junior Section):—Meeting at Newcastle-on-Tyne. Lecture by G. Shaw, M.Sc.
Scottish Branch:—Joint meeting at Glasgow. "Metallurgy of Steel Castings," Paper by A. McCance, D.Sc.

NOVEMBER 13.

Lancashire Branch (Burnley Section):—Ordinary meeting. Lecture on "Mould Gases," by E. Fowler.

NOVEMBER 16.

Sheffield Branch:—Ordinary meeting at Sheffield. "Foundry Costing," Paper by W. R. Wintle.
Middlesbrough Branch:—Meeting at the Cleveland Technical Institute. Lecture on "Pattern-Making."

NOVEMBER 17.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "Shrinkage Holes in Small Grey Iron Castings," Paper by P. A. Russell.

A Recruit.

After years of propaganda in this column, we were obviously delighted to hear Sir Philip Nash state, in his Presidential Address to the British Cast Iron Research Association, that the absence of a truly national federation of foundry owners did not exist, and we infer that he deplored this as it caused the Association officials the arduous task of individual approach.

Whilst the question of research is of exceptional importance, we still insist that the vital necessity in the foundry industry is for it to be rich. It is patent to everybody that the existing system of incipient individualism has not made for intense national prosperity in the industry—though there are several bright spots. What serious co-operation would do is a matter of conjecture, but the following are obvious:—Primarily, Major-General Sir Philip Nash would have no difficulty in securing his £25,000 a year, and, indeed, he might easily bank on a "capital" fund for the adequate housing of research work. Then our national organisation would be in a position to co-operate with the trade unions; install nationally a unified system of costing to prevent those dangerous mistakes which occur periodically, and react so violently on general price levels; draw up protective measures for the safeguarding and improving, if necesary, the (commercial) customs of the trade; collect the statistics for the industry—a factor sadly deficient at the moment; treat with the Railway Rates Tribunal, rating authorities, and effect similar national functions. So we could continue citing the desirable functions capable of being performed adequately only by an extremely representative organisation. We hope that our recruit will use his very great influence in engineering circles to promote what appears to be a sound rational development in British industry.

An Engineer on Cast Iron.

We have seldom heard the peculiar difficulties of the founder put more convincingly and more interestingly than was done on October 31 by the President of the Cast Iron Research Association. The occasion was the luncheon which followed the annual meeting of the Association, details of which are reported elsewhere in our columns. We believe that this is only the second luncheon of the kind that the Association has held, so that it is not an annual event, yet we are inclined to think the experiment would be justified even once a year.

The list of guests revealed an astonishing variety of interests—the leading scientific and technical institutions, trade associations, universities, livery companies, Government departments. In some way or another all these bodies are concerned with foundry products, and the principal officers have considerable power to determine the interest their institutions take in the Association. They probably would never acquire the necessary information through printed matter, but persuade them to gather round the festive board and they are compelled to listen. On this occasion the lesson was all the better learned by the wit which accompanied the delivery.

We do not propose to comment on Sir Philip Nash's address in detail because it is available elsewhere. He laid particular stress on the strength of the Association—its concentration on the one object of founding: he also pointed out the weakness of the arrangement, for, because founding is everybody's business, it is nobody's business.

The suggestions made of what the Association might become were of the highest interest, if only because they indicate an aim in view, and not merely a spasmodic and unregulated growth. The really trifling nature of the cost is shown when it is put as a cost per ton of finished castings, say 1½d. per ton. A single inspiration or idea taken from a report or a meeting might very well save such a margin on a month's output. We venture to think that within ten years the industry will not know how it ever was possible to get along without the services of the Association. As fast as this penetrates to even the most aloof foundry owner, so fast will the Association grow in resources and prestige.

We would like to direct special attention to Sir Philip's warning regarding fabricated steel as a rival to cast iron. An engineer is wedded to neither, and will choose that which best suits his purpose. And the founder who asserts that the engineer will never pay for improved castings will be surprised if his business is taken away in favour of a more expensive basic material. We maintain that engineers, in their choice of material, while naturally looking at price, have also to pay regard to quality, fitness for purpose, weight, strength, resistance to wear and corrosion and so on. Price is a relatively minor factor, and never yet deterred an engineer from making a change.

The range of materials used in modern engineering practice is extraordinarily wide, and even what we should usually call the rare elements and precious metals are pressed into service when no alternative will suffice. The engineer, however, will not pay an increased price unless there is obviously some increased value in life, in service, or some compensating factor such as reduction in weight, which, as we have so often insisted, will not prejudice the foundry trade. Tonnage may very well diminish and increase values, prices and profits result, and that, after all, is the main consideration.

Falkirk Ironfounder Honoured.

Presentation to Mr. Andrew Wallace.

At a luncheon given by members of the National Light Castings Ironfounders' Federation in the Grosvenor Restaurant, Glasgow, Mr. Andrew Wallace, J.P., of Falkirk, who was the guest of honour, was the recipient of a silver coffee pot and cheque, in personal appreciation of his many years of valuable work in their interests.

In making the presentation, Mr. John King, J.P., chairman of the Federation, made reference to the aims and objects of the Federation, and said that it had been conceived and maintained on the basis of mutual trust and co-operation. The governing principle of the Federation was, of course, the protection of its members, but consistent with that it had always followed the policy of seeing, appreciating, and giving effect to the point of view of the other side to the greatest possible extent. The carrying out of the work required men of experience and ability, and in Mr. Wallace the Federation had just such a man. In dealing with Federation questions both as convener of No. 1 District and as leader of the Wages Negotiating Committee, Mr. Wallace had very ably exercised those necessary qualities of tact and judgment which the discharge of the work required. That work brought the Federation into close contact and relationship with the Trade Unions, and in negotiating with them Mr. Wallace had always kept in the forefront the principle he had before enunciated of recognising the rights of the other side and giving effect as far as possible, to their legitimate claims.

Mr. Wallace, in reply, said he was very much touched by this tangible token of appreciation of any services he had been able to render. He had been a worker all his life, and indeed had found his greatest enjoyment in work, but of all work in which he had engaged, whether public or private, there was no branch he had more thoroughly enjoyed than the work he had performed on behalf of the Federation. He counted himself fortunate, however, that both as chairman of No. 1 District and as leader of the Negotiating Committee, he had been supported by so loyal and helpful a body of colleagues.

Mr. George Scotland, of the Falkirk Iron Company, Limited, in an able and racy speech, supported and supplemented the chairman's statement regarding the valuable work which Mr. Wallace had carried out on behalf of the Federation.

Mr. Logan, of the Ironfounding Workers' Association, who was present at the gathering, Mr. T. P. Cameron, of Messrs. Cameron & Roberton, Limited, and the Federation secretary, Mr. Blair, also contributed a few remarks in appreciation of Mr. Wallace's services.

West Riding Ironfounders at Phœnix Works.

About fifty members of the West Riding Branch of the Institute of British Ironfounders inspected the Phœnix Works of the English Electric Company, Limited, at Thornbury, on Saturday.

Specially interesting were the new balancing and up-to-date drilling machines, and in particular the new development in regard to the local staple industry in the shape of a variable three-phase motor, self-contained, and with a switch on the top, specially designed for ring-frame spinning. It was also mentioned that the whole of the men employed in the shops were Bradford men, that every machine was electrically driven, and that the whole of the current used was supplied by the Bradford Corporation.

The directors of the company entertained the visitors at high tea. Mr. H. Rhodes, works manager, and Mr. Midgeley, production manager, were responsible for the arrangements, assisted by a specially selected staff of expert guides.

During the evening, the members of the Institute visited the foundry of their President, Mr. W. G. Thornton.

A Remarkable Cup.

By H. Littlehales.

The cup illustrated below is probably a unique example, for it is not made from one of the precious metals but of latten, or, as we should to-day call the alloy, brass. This strange fact, which would probably preclude the cup from being a saleable article, seems in a measure to point to the possibility of it having been made by a metal craftsman for himself. He may not have been able to afford silver, but in the workmanship, costing nothing, he would, if our surmise be correct, have a fine specimen of his own work at little cost.

The cup originally was gilded, which would make it, when fresh from the craftsman's hands, a cup of very striking appearance. The lines of this cup are of much beauty, though its stumpy form detracts from its grace as a whole. It will be noticed that the beauty of the cup is dependent on its moulded lines alone, there being, apart from the inscription, no attempt to add any ornamentation. This cup is one of that class known to-day as Tazze. The tazza was a purely domestic table vessel, and came into very common use in the time of Henry VIII. Its distinctive features are the broad shallow bowl, thick stem and bold foot. The inscription on the cup is in Latin, and is to the effect that wine should be used in moderation. The significance of the barely distinguishable xv just above the v in lvxuria of the inscription is a very curious instance of a craftsman's mistake. He had forgotten the xv, so put it in on top!

A Remarkable Cup.

Of these cups a fair number remain to-day, some enriched with boldly embossed surfaces. A few have found their way into churches for use as sacramental vessels.

For our illustration we are indebted to the Director of the Victoria and Albert Museum.

Reports and Dividends.

Pease & Partners, Limited.—No interim dividend.

Bolckow, Vaughan & Company, Limited.—Profit for year ended June 30, £297,103; standing charges on idle plant, £49,250; writing down of stocks, £11,754; bank and loan interest, £47,344; debenture interest, £121,491; brought forward, £42,045; carried forward, £109,307. Expenditure upon capital account during the year amounted to £9,096. No depreciation has been charged in the year's accounts.

Ransome & Marles Bearing Company, Limited.—Profit, after providing for depreciation, £38,555; brought forward, £30,852; dividend of 8 per cent., less tax, £28,800; to general reserve, £15,000; carried forward, £25,608. The directors propose that the item "patent rights, trade-marks and licences," standing in the balance-sheet at £39,263, be written off, using for this purpose the special reserve of £31,686, and taking the balance from general reserve.

Random Shots.

The opening of the new high level bridge at Newcastle-on-Tyne puts a modern steel bridge alongside one of the great cast-iron bridges of the world, and the contrast is a silent but very telling commentary on progress.

* * *

The new bridge is very pleasing to the eye, and, in fact, forms a very convincing illustration of the idea that even constructional steel can be beautiful provided it is arranged in a design supremely well fitted for its purpose.

* * *

Although the modern iron and steel industry began with Dud Dudley, he was somewhat before his time, and cast iron is usually reckoned to begin with Abraham Darby, whose foundry at Bristol worked behind locked doors for over a century. Subsequently, Darby leased the famous Coalbrookdale works, and died at the early age of forty, in 1717. Darby's son increased the business, and in 1754 started a works at Horsehay.

* * *

It was during the management of a grandson of the original Darby that the first cast iron bridge was built, this, of course, being at the place now known as Ironbridge, on the Severn. Cast iron had come to stay.

* * *

I was present at the annual meeting of the Cast Iron Research Association, and have seldom seen routine business, inevitable but tedious as a rule, got through with such dispatch. About ten resolutions were disposed of in twice as many minutes.

* * *

The subsequent luncheon offered an interesting illustration of my recent comments on after-dinner speeches. The remarks of the President will, I imagine, be reproduced elsewhere. They are worth it. But they were enlivened with a touch of humour, and the delivery was admirable. Mr. Tizard, who followed, is a real discovery as an after-dinner speaker. Only superlative skill and cleverness could lie behind an effort so artlessly and yet so tellingly done. Mr. P. J. Hannon, M.P., rounded off the rest by the marked contrast of an exuberant personality, and his remarks provoked roars of delighted laughter, not less by the matter than by the manner. We shall suspect Mr. Hannon of coming from Ireland.

* * *

Altogether a delightful occasion, which managed to be extraordinarily different in atmosphere from a foundry convention.

* * *

Many readers will remember Mr. W. T. Layton, who has just been appointed financial assessor to the Simon Commission on India, as the former Director of the National Federation of Iron and Steel Manufacturers. He was a member of the World Economic Conference at Geneva, which adopted the famous proposals urging rationalisation in industry. Altogether, he is one of those very brainy men who make even the depleted Liberal ranks a matter of envy to the other political parties. It would be interesting to know his views on safeguarding iron and steel, but I fear that he would be orthodox.

* * *

A Few More Howlers from Mr. Hunt's Collection.

Tarzan is a short name for the American Flag. Its full name is Tarzan Stripes.

Christians are only allowed one wife. This is called monotony.

Acrimony (sometimes called holy) is another name for marriage. Solomon was very fond of animals because he had 300 porcupines.

Salome was a very wicked woman who wore very few clothes, and took them all off when she danced before Harrod's.

The Soviet is what the middle classes call their napkins.

And One From My Own.

The Te Deum is what people get when they consistently drink too much alcohol.

Marksman.

British Cast Iron Research Association.

SIR PHILIP NASH ON THE FOUNDRY INDUSTRY.

The President (Major-General Sir Philip Nash) presided over a distinguished gathering of members and guests at the luncheon which followed the annual meeting.

PRESIDENTIAL ADDRESS.

In his Presidential address he pointed out that historically engineering originated in the foundry, and even to-day, remarkable as had been developments since the time of Watt, about one-half the tonnage output of engineering products comprised cast or malleable cast iron. The basic character of the industry was evidenced by the variety of institutions, both in engineering and metallurgy, represented at that gathering, for founding was not only conducted independently, but was carried on as an auxiliary process in all kinds of engineering establishments, marine, textile, automobile, electrical, railway, etc., and also at steelworks and blast furnaces. In this country we attached great importance to historical continuity. We did not found new institutions until they were long overdue, and it was our characteristic rather to adapt and mould existing institutions to serve new ends. The representatives of the industry present at that gathering were fortunate in being reminded of the industry's historical origin by the presence of representatives of the Worshipful Company of Founders and of the Armourers' and Braziers' Company, ancient foundations of the great City of London.

The British Cast Iron Research Association was unique in that it concentrated entirely on the problems and possibilities of founding, a unity of interest which was advantageous because there was no temptation to dissipate its energies over a wide field. There was no need at this stage to justify co-operative work in the industry; he had already referred to its ancient origin and its wide application to an astonishing range of products, both engineering and domestic. In addition, the belated application of metallurgical science and the progress of our American and Continental rivals emphasised the need. Obviously, no foundry development could be confined exclusively to one works, nor could any single organisation undertake the whole of the work required. The company over which he presided had large foundries, and yet found it necessary to call upon the services of many others; so far from desiring to obtain exclusive information, they wished that all their suppliers might share in the responsibility and advantages of membership of the Association.

Main Divisions of Work Covered.

Dealing with the scope of the Association's work, the President said that those who used materials built up synthetically from carefully refined pure bases had a simple problem compared with that of the man who was compelled to use re-melted pig-iron, the first product of the refining process, mixed with raw coke, melted in furnaces lined with naturally occurring refractories, and moulded in naturally occurring sands. The work of the Association thus comprised three main sections:—First, that extraordinary range of materials which we slurred over rather than summed up as "cast iron"; secondly, the furnaces in which it was melted; and thirdly, the fuels, sands and refractories with which it was in constant contact. Not only had the Association to carry out the experimental work, but, as far as possible, to apply the results to the works. The Council had always before it this problem of bridging the gap between the laboratory experiment and its incorporation as a matter of course into routine production. If the man in the works were enthusiastic, the problem was simplified. By the issue of brief and non-technical reports, by staff visits to members' works, by private discussions several times each year in the leading industrial centres, by consideration of practical foundry problems or the difficulties of individual applications, by large-scale experiment under commercial conditions, the Council endeavoured to bridge this gap and to deal with work frequently referred to as "factory development."

Education a Dominant Factor.

During the past year this work had extended in several important practical directions. Full-scale and extensive cupola trials had taken place in no less than four members' works, while a start had been made in providing the Association's own melting plant. The research programe showed notable progress, as indicated in the annual report. The realisation of the benefits of research in the industry in the future largely depended on the nature of the personnel in the foundry. The Association was thus keenly concerned with education and training for all grades employed in the foundry, and evidence of the recognition of this fact was to be found in the appointment of the Chairman of the Association's Education Committee to the new Board of Education Committee for the inquiry into training for the engineering industry.

International Developments.

What an asset industry had in the Association might be estimated by a consideration of the way in which it was regarded on the Continent and in America. Several recent movements of a co-operative character among founders abroad appeared to have originated in the interest aroused by the formation of the Association. To these countries, however, and especially Germany, research in cast iron and its related products was no new thing, and the officers of the Association had had an arduous task in building up within a few years an organisation capable of doing work equal to that which had been sedulously pursued elsewhere for several decades. He hoped the members would, as far as financial conditions permitted, encourage their officers to keep in touch with developments abroad by visits to works and by personal contact with eminent workers. He believed that in the Association they achieved a contact between experimental work and laboratory progress which promised even greater achievement than that of older institutions in other countries. A further advantage lay in the provision made in its constitution for the membership of pig-iron producers and equipment and supply houses as well as foundries. Ultimately, their interests and those of the founders were one and the same—to develop a progressive and enlightened industry. The Association welcomed also the membership of producers in the Dominions. The Council had never felt so confident of the success of the Association as at present, and believed that we were on the eve of interesting developments.

The Future.

As to the future, he asked what might reasonably be expected of the Association, supposing it to have the united support of the whole industry, and to be able, therefore, to undertake work which at present must remain a vision of the future? Taking for its province the founding of the ferrous metals, it would, he suggested, be housed in its own buildings, with laboratories, workshops, administrative offices and library under one roof, although for large-scale melting operations it would continue to rely upon the industry, where commercial work was constantly in progress. The research staff would study specific questions aiming at a definite objective desired by the industry. The Information Bureau would extend greatly its scope. In addition, there would be a special staff for dealing with "factory development, *i.e.*, with the applications of new knowledge in the works, with the problems which inevitably arose every day in the foundry, and with raising the works to and keeping them at the highest level of efficiency as far as purely technical matters were concerned. This staff would be a "flying-squad," available at short notice anywhere, and would represent the personal end of the Association's advisory service. He could conceive such a staff supervising the plant and incubating the production of new types of iron, and handing it over to the works in full running order. Finally, he could conceive that in each great area of the trade a small laboratory on the lines of the Association's existing Scottish laboratory, which concentrated on light castings work, could be organised to deal with purely local problems, for not only did particular sections of the trade tend to concentrate, but the raw materials often exhibited purely local peculiarities.

Training Facilities.

He would like the members to draw on the staff of the Association when they required services of specialists or of juniors, and he believed that such interchange of staff would be beneficial both to members and the Association. The Association was prepared to offer facilities for specialised training for men already engaged in the works of members, and would be prepared to receive university graduates and others either from this country or the Dominions for specialised training likely to be of service to the industry. Was it beyond the scope of the industry to realise such a state of affairs? Such an undertaking would probably require not more than two or three times the present income of the Association, say, £25,000 per annum, which would represent a charge of about 3d. per ton on foundry pig-iron produced in the country, or 1½d. per ton on finished castings. Such a figure was a small premium to pay for insurance against losses and wasters, and the inevitable depreciation of our present trade knowledge.

The Inarticulate Foundry Managers.

There were difficulties, however. The unity of work of the Association, concentrated upon founding, was an advantage, but was one for which a certain price had to be paid. It created one of the Association's difficulties, for no single employers' association was concerned with founding to the exclusion of all else. It was the province of a number which had other trade interests. Therefore, the Association had to seek members by the slow process of individual approach. The industry presented a curiously paradoxical position. It was isolated, detached in spirit and in character from the engineering crafts by virtue of the peculiar nature of its materials and methods. At the same time, it was attached to many engineering works, few controllers of which had had actual foundry experience and few foundry managers of which were articulate enough to present with sufficient force their special difficulties and requirements.

Revenue, But No Capital.

The final difficulty originated in the fact that the Association had no capital. Hitherto the Council had provided essential equipment and apparatus out of income because they had felt that industrial conditions did not warrant an appeal to members. In certain directions the members' interests were being jeopardised by inability to obtain the tools of the Association's trade, and this matter was one which the Council had to consider in the near future.

The Research Stimulus.

Emphasising the value of research and the benefits it conferred, the President mentioned particularly three facts, the importance of which his experience had taught him. In the first place, he regarded research as an insurance against being taken by surprise. A well organised and properly constituted research department was a comfort, and one felt that the workers in that department would get to know a thing before the other man could spring it on one. In the second place, research prevented that time lag which had occurred in the past between the date of a scientific invention and the date of its commercial application. Thirdly, the presence in the works of research workers, whose training was different from that of the ordinary personnel, and who had a different class of brain, tended to elevate the whole scientific qualification of the staff. Dealing with the problems before the foundry industry to-day, he mentioned particularly the development of fabricated steel to replace cast-iron frames, and so on. He knew that it was affecting his own foundry. It might be said that fabricated steel structures of that sort had not yet proved themselves; that might be so, but he was certain that their day would come, and that was another very strong argument in favour of the concentration of scientific research with a view to improving the

methods and cheapening the cost of producing castings. The use of the fabricated material was growing at a tremendous pace, and it was going to affect the foundry industry.

The President concluded with an appeal to all to lend a hand in persuading people to adopt with courage the best methods they could, to enable the country to recover the position she ought to have, and which she would have, *i.e.*, the premier position among the industrial countries of the world.

A Dual Personality.

Mr. H. T. Tizard, C.B., F.R.S. (Secretary, Department of Scientific and Industrial Research), said:—When coming to this gathering I found myself reflecting that every Government servant leads a kind of double life; for the major part of his time he is a very hard-worked individual, engaged in the spending of the taxpayers' money, whereas during his very small amount of leisure time he is concerned with the paying of his taxes. Last night my tax-paying self had a serious conversation with my tax-spending self, and the conversation was on these lines:—

"I hear you are going to the British Cast Iron Research Association's luncheon to-morrow?"

"Yes."

"Well, how are they getting on?"

"They are doing very well indeed."

"Tell me something about them."

"Well, they have completed a great deal of work on the efficiency of melting pig-iron, and have shown how considerable economies can be effected at very small capital cost. They have cleared up the whole question of whether manganese is bad or good in cast iron, and have shown that in certain directions it is bad, and why, and that in other directions it is good, and why. They have placed the whole problem of moulding sands on a scientific basis, and quite recently have done a great piece of work on the effect of silicon in cast iron, a piece of work of such importance that quite possibly it may make the whole difference between the success and failure of some low-temperature carbonisation processes."

"That is good. I hope, however, that they will not give you a very good lunch; I have subscribed to their funds for eight years, you have promised them more of my money for another few years, and if they give you a good lunch you will promise them still more."

"I am sorry, but I understand that that has already been done."

"Why?"

"Major-General Sir Philip Nash and a number of other eminent gentlemen have talked to the Lord President (Earl Balfour), and have persuaded him that it is a good thing to continue offering your money for a further period."

"Good heavens! Do you mean that you can connive at this?"

"Yes, because we honestly think that it is in the national interest to do so."

"That is what always happens. Whenever I am asked to do anything unpleasant, I am told it is in the national interest. Now you have told me that the Association is spending something like £8,000 a year. I have calculated that that corresponds to about a penny per ton of pig-iron used for making castings."

"Do you mean to say that you cannot save a penny per ton of pig-iron by scientific work? What about your economy of melting? A penny per ton of pig-iron represents, say, 10 lbs. of coke, to be on the safe side. Cannot you show how to save 10 lbs. of coke per ton of iron?"

"Yes. The Association have shown how to save 50 lbs."

"Fifty lbs.! That corresponds to over fivepence per ton of iron. Why don't they pay up?" (Laughter.)

"You do not understand these things. Such arithmetic is not popular, except within a very small intellectual circle. If you knew more about industry you would know that whereas two and two make four in ordinary life, in industry there are so many complications that they are just as likely as not to make minus four."

Further Support Forthcoming.

I will apologise (said Mr. Tizard) for my tax-paying self: he is suffering from a severe cold and is slightly depressed, and in a few days' time will take a different view of the matter. The Lord President, on behalf of the taxpayers of the country, has promised further support to the Association for a number of years if the industry shows that it is determined to do its part to keep it going. Let us pay a tribute to ourselves as taxpayers. I do not know whether you realise that this is the only country in which the taxpayer as such has in a very difficult period put aside very large sums of money for research in the general interests of industry. In America a great deal of money is spent on research by private individuals: in Germany a great deal of money is spent on research, but the taxpayers there have borne a very small proportion. In this country, although we hear every year that the burdens of the taxpayer have increased, you will find that whenever a reasonable proposal is put before the representatives of the taxpayer for expenditure on research it meets with uncommonly little opposition; indeed, it meets with real enthusiasm. We hear much about new industries based on scientific discoveries; but new industries will never become fully fruitful unless we can make the older essential industries better and more productive. The object of expenditure on this Association is the definite one of making the cast iron founding industry better, of improving its productions both in quality and quantity, and of lowering their cost. Therefore, when we make an appeal for support for this Association we do it, not on charitable grounds, but for the simple reason that we think that the industry will gain by it.

Mr. P. J. Hannon, M.P., who proposed the toast of "The President," said it had fallen to his lot, as a member of the Estimates Committee of the House of Commons, to champion the cause of research on more than one occasion. He mentioned that recently a deputation, pleading for a larger measure of consideration for the home industries against those who competed with us abroad, had waited upon the Prime Minister, and one of the points made by Sir Robert Horne was that, for a whole series of reasons, following on the war, we were not in a position to maintain industry at that vitalised level possible in other countries. The Prime Minister, who was kindly and friendly, but eminently reticent, had said that in the great basic industries of this country there was an immense leeway to be made up in the direction of greater efficiency. That very fact, which he believed nobody would challenge, made us feel how important it was to encourage research by every means in our power. He (Mr. Hannon) recalled that when the Estimates Committee of the House of Commons had had to examine the extent to which research was being assisted from the taxpayers' pockets, he had urged very strongly that however otherwise we might economise in relation to the general cost of administration, it would be more or less an act of suicide to cut down the sustenance afforded by the State to the continued expansion of research.

The toast was honoured with enthusiasm, and the President briefly responded.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their "Statistical Bulletin" for September, report that the production of pig-iron in September amounted to 503,900 tons compared with 519,000 tons in August, and 591,500 tons in September, 1927; the daily rate of production in September was slightly higher than in August (16,797 tons compared with 16,742 tons). The number of furnaces in blast increased by one during the month, three furnaces having ceased operations and four were blown in during the month. Steel production in September amounted to 718,000 tons, an increase of some 70,000 tons over August, when production was curtailed by holidays, but nearly 60,000 tons less than in September, 1927.

A Teesside Foundry Comes of Age.

Twenty-one years ago Mr. Harry B. Toy introduced a new and distinctive branch of the iron and steel trade to Teesside.

That modest beginning, the successful development of the business, and its coming-of-age, were referred to at a gathering of the employees and staff of the British Chilled Roll and Engineering Company, Limited, Empire Works, Haverton Hill, held in the Grand Hotel, Middlesbrough, last week. The guests numbered 200.

Mr. Fred E. Fisher (head foreman) was in the chair, and after dinner Mr. T. E. Bashford (accountant) made presentations to Mr. Toy, who is chairman and managing director, and also an ex-president of the Cleveland Institution of Engineers, and to Mr. John L. Smith (works manager and secretary).

Mr. Bashford said that at the time of the inauguration of the company the iron and steel trades were depressed. Mr. Toy, however, had faith in the old country and especially in the North-East. His confidence was fully justified. Mr. Smith joined Mr. Toy two years after the business had been launched.

In spite of trials and disappointments, they had been 21 years of pleasant memory, and years when the management had always shown a steady attitude towards troubles. The firm had been able to give as regular employment as any concern in the country. (Applause.)

Mr. Bashford then presented Mr. Toy and Mr. Smith, with large, framed portraits in oils, both by Mr. F. Appleyard, of Itchenstoke, Hants, a native of Middlesbrough.

Mr. Toy, in reply, said that he would always look upon his picture as a token of how employers and employed could work amicably together.

Mr. Smith also paid compliment to the high calibre of the firm's workmen.

Other Presentations.

Miss Manning (secretary), on behalf of the staff and workpeople, presented mementoes to members of Mr. Toy's and Mr. Smith's families, as follow: Mrs. Toy, large crystal fruit centre; Mrs. McLeod, coffee set in case; Miss Toy, silver and tortoise-shell shingle set and case; Miss Smith, silver-gilt and enamel clock; Miss M. Smith, silver and tortoise-shell brush set in case; and Mr. Sydney V. Toy (President of the Middlesbrough Branch of the Institute of British Foundrymen), case of silver military hair brushes.

Mr. Toy also received a silver and gold match-box, and Mr. Smith was presented with a silver snuff-box.

A programme of music and dancing followed.

Germany Inaugurates Foundry Competition.

The Committee of the Verein Deutsche Eisengiessereien, Giesserei Verband is offering prizes for a Paper on the subject given below. Four prizes are offered: 1st, 2,000 R.M. (£100); 2nd, 1,000 R.M. (£50); and 3rd and 4th, 500 R.M. (£25). The winning Papers will be published in "Die Giesserei."

Papers, in quintuplicate, must reach the Geschäftstelle of the Association, 29, Breitestrasse, Düsseldorf, in a sealed envelope, bearing a pseudonym, not later than January 1, 1929. The same pseudonym is to be written on a second envelope containing the sender's full name and address. The subject chosen is "Under what conditions, in regard to quantity and uniformity of product, is the continuous casting process, or the utilisation of conveyor systems, economical in the complete production of castings, or in only a portion of the manufacturing process. In dealing with the subject, the saleability of the products must be taken into consideration." Further information, such as to whether non-German nationals are eligible, will be sent on application.

Alloy Cast Iron.*

By D. Hanson, D.Sc., Professor of Metallurgy, Birmingham University.

(*Continued from page* 321.)

Nickel and Chromium in Cast Iron.

We have examined the effect of nickel in cast iron and have pointed out its characteristic action. In the development of alloy irons, other elements will play their part, and it is necessary to examine the effect of such other additions on the action of nickel. The only other addition that has as yet received much consideration is chromium. The action of chromium differs in certain important respects from that of nickel. Nickel promotes the formation of graphite, but hardens the matrix; silicon is a graphitising agent both above and below the critical range, and softens both the carbide and the matrix of the iron. Chromium, on the other hand, is a carbide-forming agent as well as a very effective matrix-hardener. Thus, while it acts in the same sense as nickel on the matrix it acts in the opposite sense in regard to chill, which is rapidly increased by chromium additions. The use of chromium alone is therefore likely to accentuate troubles due to chill, hard spots and difficulty in machining.

Experiments have shown that nickel preserves its characteristic effects in the presence of chromium. Its action on chill is no less pronounced, as is well illustrated in Fig. 7, which

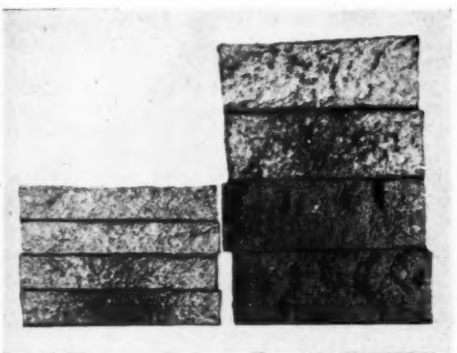


FIG. 7.—ACTION OF NICKEL OR REFINED IRON CONTAINING 0.5 PER CENT. CR.

shows the fractures of a series of steps from castings made of a refined iron containing 2.8 per cent. carbon and 1.7 per cent silicon; the chromium is constant throughout the series at 0.5 per cent., while the nickel is nil in the top fracture, and 1, 2, and 3 per cent. respectively in the lower fractures.

The effect of nickel in equalising the hardness of different sections is demonstrated in Figs. 8 and 9. Fig. 8 represents the hardness of the steps in castings of the refined iron containing 2.8 per cent. carbon; 1.75 per cent. silicon; 0.6 per cent. manganese; 0.05 per cent. sulphur; and 0.14 per cent. phosphorus.

The reduction in chill is also illustrated in the sections of the step-bar casting included in this diagram, the black shaded area representing the chilled iron.

The equalisation in hardness of the different sections is in part due to the reduction in chill of the thin parts, and in part to the hardening of the matrix in the thicker sections, the action of nickel being here identical with that already described of irons containing no chromium. The same equalising effect is shown in Fig. 9, which refers to an automobile cylinder iron, containing 3 per cent. carbon; 2 per cent. silicon; and low sulphur and phosphorus. The comparison here is really between the original iron containing no alloy addition and the same iron after the addition of 1 per cent. nickel plus 0.25 per cent. chromium, the silicon content being maintained constant throughout.

* A Paper read before the Birmingham Section of the Institute of British Foundrymen.

The equalising action of nickel and chromium is here well demonstrated in the production of widely varying sections of readily machinable iron with Brinell numbers varying only from 228 to 241.

It is clear that while the characteristic action of nickel is preserved in the presence of chromium, the introduction of another element with such a marked chilling tendency must be taken into account in deciding the amount of nickel suitable for any particular purpose.

Chromium acts in the opposite sense to silicon in its effect on chill, and the same adjustment in the silicon content is not, therefore, necessary when chromium is present. According to Houston, one point of chromium is roughly

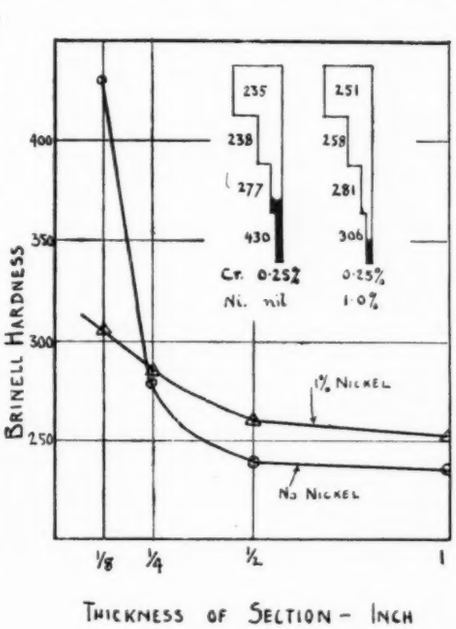


FIG. 8.

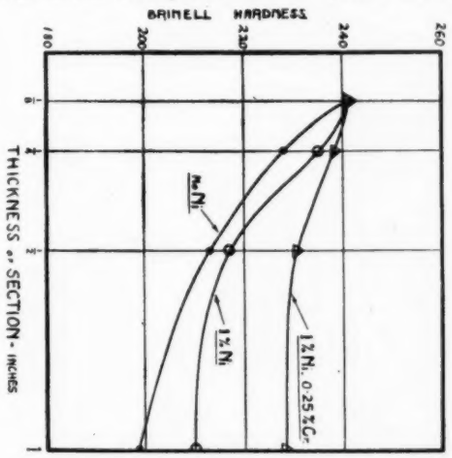


FIG. 9.

equivalent to two points of silicon in respect to chill, and since nickel acts in the same sense as silicon, then one point of chromium is roughly equivalent to two points of nickel. This equivalence doubtless varies somewhat with the grade of iron used; the author's experience suggests a figure more nearly approaching 3:1. These relationships can be utilised to meet important practical needs, experienced particularly by foundrymen making a large variety of castings from the same cupola, since the addition of chromium in suitable proportions can be made instead of a reduction in the amount of silicon, to compensate for the amount of nickel added. The results shown in Table III show the improvement in properties of an automobile cylinder iron brought about by the combined addition of nickel and chromium in this manner. The addition of nickel alone had produced a slight improvement in the hardness of the thicker sections, and a slight increase in tensile strength. The simultaneous addition of chromium has resulted in considerably greater improvement both in the hardness and tensile strength, while the chilling tendency of the iron is less than when no alloy was added. In these tests, a nickel to chromium ratio of rather less than 3 : 1 appears to have produced an iron of practically equal chilling tendency.

While chromium can be used as described to neutralise silicon, it is necessary to remember that this substitution cannot be carried too far, and that irons very high in silicon may give disappointing results on account of the open grain produced by this element. Reduction of silicon is much more effective in refining the grain than addition of chromium, and in such a case, if the best results are to be obtained from alloying, the silicon should be reduced at least to such a point as will ensure a satisfactory graphite structure in the iron.

The combined effect of nickel and chromium in suppressing the formation of pearlite is well known in connection with alloy steels, and is equally effective in producing a sorbitic structure in alloy cast irons. This can be utilised to give improved hardness and resistance to wear, and, with proper adjustment of the alloy additions, to eliminate hard carbide spots, these qualities can be obtained in an iron that is readily machinable. Such a use of alloy cast iron is already being made with success in the production of cylinders and cylinder liners, dies, grey iron rolls, etc., where a combination of these qualities is required.

Effect of Nickel in the Presence of Phosphorus.

We have so far only considered cast irons in which the phosphorus content is quite low. Many of the irons used in this country for the production of high-grade castings contain appreciable amounts of this element, and it is therefore important to know how its presence affects the influence of alloy additions. Dr. Everest and the author have carried out a number of experiments on phosphoric irons which throw an important light on this question.

TABLE III.—*Effect of Nickel and Chromium on Cast Iron.*

Material: Automobile Cylinder Iron, T.C., 2.9–3.0%; Mn, 0.85%; S, 0.10%; P, 0.17%.

Ni per cent.	Cr per cent.	Depth of chill on ⅛-in. step.	Brinell Hardness.				Transverse test on standard "M" bar.		Tensile strength. Tons per sq. in.	
			1 in.	½ in.	¼ in.	⅛ in.	Max. load, cwt.	Mod. of rup. Tons sq. in.	1.2 in. bars.	0.875 in. bars.
nil	trace	0.5 in.	199	213	228	241	28.15	37.3	15.3	19.4
1.02	trace	trace	210	217	335	241	26.93	35.7	16.8	18.8
1.10	0.27	trace	228	231	238	241	28.27	37.5	18.6	20.5
1.14	0.414	0.35 in.	230	238	258	269	28.15	37.3	18.0	22.45

Opinions differ as to the influence of phosphorus itself on cast iron; on the one hand it is held that phosphorus induces graphitisation and, on the other hand, that it increases the amount of chill. In the author's experiments on a refined iron containing 3 per cent. carbon and 1.8 per cent. silicon, as well as from the synthetic irons produced from a washed-iron base, phosphorus had a definite action in increasing susceptibility to chill. The influence of nickel was found quite definitely to counteract this influence, as is illustrated in Fig. 10, which shows the chill on different sections of the refined iron containing different phosphorus

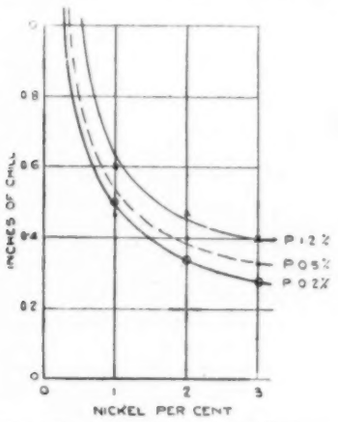


Fig. 10.—Refined Iron. Depth of Chill on ½-in. Step.

and nickel contents. The graphitising action of phosphorus was also definitely disclosed by chemical analyses of the different alloys. Step bar castings furthermore disclosed that nickel has a definite regular hardening action on all sections, except where chilling had produced white iron, when nickel is effective in removing the hard structure. It is thus possible in phosphoric irons to utilise nickel additions in the manner already discussed to equalise the hardness in different sections, and Figs. 11 and 12 illustrate this action in the refined iron already referred to. Fig. 11 shows the effect of 2 per cent. nickel on an iron containing 0.5 per cent. phosphorus, and discloses a striking equalising action on the iron. Fig. 12 shows a similar effect of nickel on iron containing 1.2 per cent. phosphorus. It was also observed that the iron containing 0.5 per cent. phosphorus was readily machinable on the larger sections in spite of the high Brinell number of 260.

Nickel and phosphorus both have a refining action on the graphite, and in irons containing high phosphorus (1.2 per cent.) the effect of nickel is very small. The action of nickel in producing a finer form of pearlite was confirmed, and it was also noticed that phosphorus itself has a definite action in this direction.

In order to confirm these observations, some experiments were carried out on foundry irons containing about 0.6 per cent. phosphorus, nickel and chromium being added to the metal in the ladle in the usual way. Table IV shows the results of some experiments on some cylinder iron containing 3.6 per cent. carbon and 1.27 per cent. silicon with 0.6 per cent. phosphorus. The addition of 0.87 per cent. nickel definitely reduces the amount of chill and produces a slight hardening effect, particularly on the thicker sections, but without appreciably improving strength; this result would be expected since the silicon was not lowered when the nickel was added. The addition of 1.18 per cent. nickel and 0.27 per cent. chromium is accompanied by a considerable general increase in hardness, and the over-all hardness is rendered more uniform, while at the same time the tensile strength is increased from 12.1 to 13.7 tons per sq. in. This improvement in properties is achieved, as shown in the table, without sensible alteration in the chilling tendency of the iron. A comparison of these results with those given in Table III for a cylinder iron containing 0.17 per cent. phosphorus shows a remarkable similarity, confirming the similarity of action of the alloy in the two cases. Figs. 13, 14 and 15 show a microstructure of the three irons tabulated in Table IV. Fig. 13 shows the structure of the original iron; Fig. 14 shows the structure with 0.87 per cent. nickel added; and Fig. 15 shows the structure with 1.18 per cent. nickel and 0.27 per cent. chromium. The refining action of the nickel alone on the pearlite is quite definite, while the nickel-

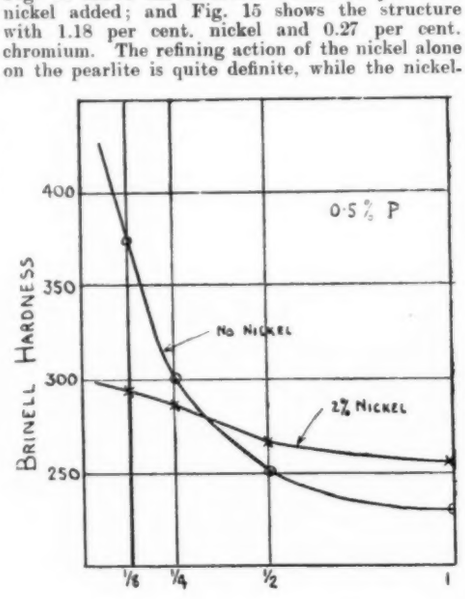


Fig. 11.

chromium additions have produced a matrix of very fine sorbitic pearlite.

The beneficial effects of nickel and chromium were also confirmed in an iron containing 3.4 per cent. carbon, 1.24 per cent. silicon, and 0.54 per cent. phosphorus, used for making cast-iron dies; the addition of 1.70 per cent. nickel and 0.4 per cent. chromium to this iron produced a very considerable increase in hardness without increasing the amount of chill, and dies made from this metal were found to have a greatly increased life. The improvement in the structure of the matrix is illustrated by Figs. 16 and 17, which show respectively the original iron, showing a well-defined pearlitic structure, and the alloy iron in which the matrix is largely sorbitic.

The results already described show that the action of nickel is substantially the same in these phosphoric irons as in similar irons low in phosphorus. In the laboratory tests it was found that slightly more nickel is required to produce a given result in the high-phosphorus irons where there is any tendency to chill, than in the lower phosphorus irons, and this is probably to be accounted for by the definite chilling action of the phosphorus in these cases. It is possible that this would not be experienced in all varieties of iron, in some of which phosphorus appears to be without effect on chill.

The presence of phosphorus in an iron has one effect which we have not yet considered, namely, that it gives rise to the presence of phosphide eutectic. This very hard constituent has a marked effect on the properties of any iron; it increases the general hardness as measured by the Brinell test, and if present in appreciable quantities has a marked effect on the machinability. Nickel appears to be without appreciable effect on the phosphide eutectic, which continues to exert its own characteristic influence. Excessive hardness or difficulty in machining due to the presence of phosphide eutectic, as distinct from the general influence of phosphorus on chill, will therefore be unaffected by nickel additions, except in so far as these additions, together with modifications in silicon content, may lead to a general refining of the iron and reduction in segregation, leading to a more uniform and satisfactory distribution of the phosphide areas.

Thus, though we see that nickel acts in a similar manner in phosphoric irons, as in irons low in phosphorus, in reducing chill, equalising hardness and improving strength, account must always be taken of the inherent properties due to the presence of phosphide eutectic. Further work is required on irons of this class, and experiments in this direction are proceeding in the author's laboratory.

Table IV.—*Effect of Nickel and Chromium on Cylinder Iron.*

Material: C. 3.6; Si, 1.27; Mn, 0.7; S, 0.12; P, 0.6. Nickel and Chromium added to Iron in Ladle.

Ni	Cr	Chill on ½-in. step.	Brinell hardness of steps.				Transverse on "M" bar.	Tensile Tons/sq. in.
			1 in.	¾ in.	½ in.	¼ in.		
—	—	0.18	190	205	227	240	28.9	12.14
0.87	—	trace	202	202	228	245	25.2	12.36
1.18	0.27	0.30	220	223	248	260	30.3	13.70

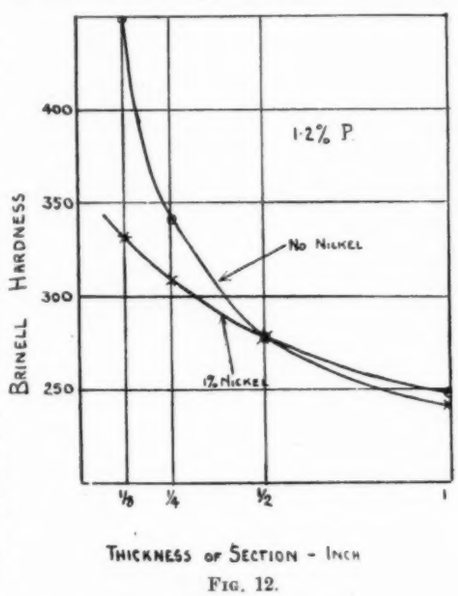


Fig. 12.

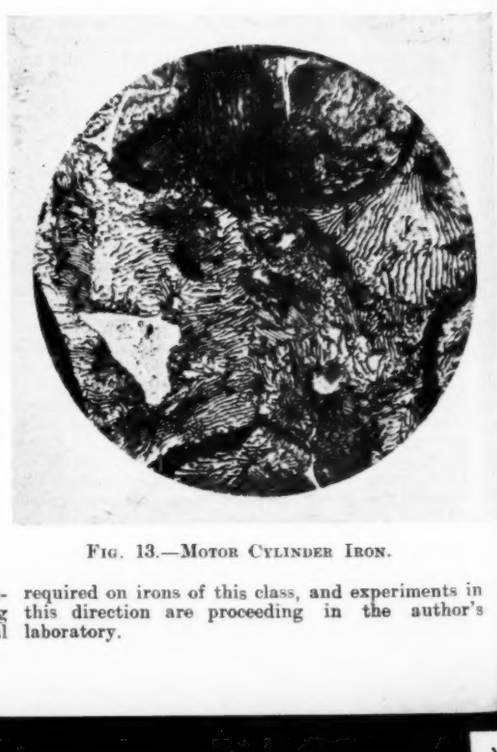


Fig. 13.—Motor Cylinder Iron.

General Conclusion.

It has been shown that the additions of nickel with or without chromium can be effective in cast iron in controlling chill, increasing and equalising hardness, raising the strength, and improving machinability. These effects are due to the characteristic action of nickel in decomposing eutectic and pro-eutectoid carbide, while maintaining a high combined carbon in the matrix on which its refining and sorbitising action can take effect. It is, however, necessary in making nickel additions to take into account not only the fundamental action of this element, but also the influence of the other elements that may be present in the iron.

The characteristic action of nickel is effective in the presence of both chromium and phosphorus, and can be utilised with advantage in the presence of those elements, provided that due attention is also given to the characteristic effects of those elements themselves.

The author acknowledges with much pleasure the valuable co-operation of Dr. A. B. Everest in the experimental work described in this Paper and in preparing diagrams and photographs to accompany it.

Fig. 14.—Motor Cylinder Iron. × 1 per cent. Nickel.

Fig. 15.—Motor Cylinder Iron. × 1 per cent. Ni and 0.25 per cent. Cr.

Fig. 16.—Die Iron without Ni or Cr.

Fig. 17.—Die Iron. × 1.7 per cent. Ni and 0.4 per cent. Cr.

DISCUSSION.

In the discussion Mr. E. R. Taylor said he was glad to hear the warning which the lecturer had issued that they could not expect the remarkable results shown unless they took into consideration the various elements of the iron under treatment. In America there had been a considerable use of nickel and chromium additions, but even so it had been suggested that the process was likely to be overdone. There was indeed a tendency towards using alloys of nickel beyond the point intended. He should like to know what were the benefits to be derived from an increment of nickel and chromium to malleable cast iron. He was interested in white heart iron, and having seen some of the results of these alloys, it seemed to him that the trouble was a liability to honeycombing and general unsoundness of the casting.

Mr. A. Harley (Coventry), acknowledging the lecture as admirable for practical men, said that if the nickel corporations would reduce the price of their product a great deal more would be used. It was interesting to notice that in dealing with low-phosphoric irons the lecturer showed that their physical values, either with or without the addition of nickel and chromium, were very much higher. The best figure shown in phosphoric irons was 13 tons tensile, and in phosphoric irons with additions the strength reached up to 22 tons. Now he preferred to do without phosphorus wherever possible, but there was one factor which they could not ignore—the question of wear. Thus, in certain automobile castings and so forth it was necessary in the majority of cases to utilise a phosphoric iron, for there was no doubt that the hard phosphide was a valuable adjunct in increasing the resistance to wear. Whether a neutralising agent could be employed, such as very low total carbon, without rendering the metal unmachinable, he did not know; but he would like to inquire whether additions of nickel and chromium would to any extent minimise the tendency of phosphoric irons to draw. Other things being equal, high phosphoric irons were without a doubt weaker than low-phosphoric irons. His experience of such irons was slightly different from that of Professor Hanson, but it was by no means definite. Now phosphoric irons, even with as low a carbon content as low-phosphoric semi-steel, had a greater tendency to chill at the corners and edges than high-phosphoric irons of otherwise similar composition. In other words,

while the phosphide eutectic deposited throughout the iron increased the hardness of the iron generally, it appeared to neutralise the tendency of the iron to chill at the edges and corners. He was referring to irons containing 0.8 to 1.0 per cent. of phosphorus, as against those with up to 0.2 per cent. Concluding, Mr. Harley asked what was the best method of adding nickel and chromium to cast iron, assuming they had considered the question of balance, for obtaining uniform results.

Nickel and High-grade Phosphorus Irons.

Professor Hanson, replying to Mr. Harley, said, in regard to the tensiles being lower in phosphoric irons, that they must remember this: in their experiments the silicon content was not lowered when nickel was added. In all other cases in which a great improvement in strength was obtained the silicon was lowered when nickel was added. He had every hope that definitely better results could be secured with phosphoric irons than had been shown on the slides. But so far they had not reached the stage of making the silicon adjustment when using those irons. On general grounds one preferred to cut phosphorus down. However, he must say there was every hope, even in irons where this was not possible, of obtaining an improvement in strength by using alloys, though perhaps not quite so high as when phosphorus was low. As to the occurrence of drawing, it had been associated with a certain amount of openness of grain, and if they could lower the silicon and close the grain, less trouble from drawing was likely. This could be done if nickel were added to replace silicon, enabling one to produce an iron of closer grain, having less tendency to drawing and to the segregation effects which occurred to a marked degree in phosphoric irons. The iron used in his experiments was refined iron, low in carbon, and phosphorus had a chilling effect. But it was by no means inconceivable that both effects should take place in irons of different types. In so far as alloying was concerned, the softening action, in regard to chill, on the part of phosphorus was probably better than the hardening action, because when the hardening action was present a little more nickel was needed to produce the desired result than when phosphorus was absent.

Additions as F Shot.

Continuing, Professor Hanson said there were several reliable methods of adding nickel and chromium. In the experiments referred to they had used principally F Shot, a variety of nickel containing about 6 per cent. silicon, 92 per cent. nickel, and small amounts of iron and other elements. It had a melting point approximating to that of cast iron, and was absorbed readily. Pure nickel shot could be added and absorbed satisfactorily if care was taken to ensure adequate heat in the molten iron. It was advisable in making alloy irons to run the cupola hot so that sufficient heat was always secured. In using the ladle it was necessary to run a little metal into the bottom of the ladle, and then sprinkle the shot into the stream, thus ensuring that the nickel shot was mixed before the ladle became full. As to chromium, that could be added either in the form of powdered ferro-chromium, or in a combined form with nickel known as Nichrome B. In the first instance the addition was powdered fairly fine, but the dust should be screened away, otherwise losses were likely to be high. The advantage of adding the alloys separately was that the user was not bound to one ratio of nickel to chromium; in their experiments they obviously preferred to make separate additions of nickel and ferro chromium.

Mr. Harley observed that low phosphoric irons were more susceptible to chill, but undoubtedly phosphorus hardened the metal (he instanced green sand moulds as causing corners and edges to become chilled). Mr. J. B. Murray inquired whether the lecturer had noticed if the formation of graphite, with the silicon unaltered, became coarser and flaky. If so, the hardening of the matrix would be nullified by that coarsening, and in that case, he took it, the effect of the nickel would be abortive. When ferro-chromium was put through the cupola there was a tendency to lose more chromium than nickel. If it was run through the cuopla a ladle was necessary to give a proper mixing to the alloy, otherwise the only alternative was, as the Professor said, to use chromium in powdered form.

Some Practical Hints.

Dr. Everest quoted an instance of complicated motor-cylinder work in which there had been an equalisation of chill without softening the casting, which was of very different thicknesses. Experiments had shown that low-silicon nickel irons could be produced which indicated a very definite advance not associated with ordinary cast iron. Nickel did not appear to exercise any injurious effects, and they could assume it was perfectly safe to add nickel even if the iron was unsuitable. Dealing with the cost of nickel from the economic side, Dr. Everest said that for the extra 30s. per ton on their alloy product—nickel being reckoned at £175 per ton—they gained a greatly improved metal, and they could still obtain good quality with a cheaper base material. However, on the question of rejects alone they could effect a considerable saving in scrap which would counterbalance that additional cost, quite apart from a better quality casting. Regarding the method of adding nickel, for continuous production it should be put through the cupola, but for ordinary jobbing work added to the ladle. Ordinary nickel pellets should not be added in the ladle, being too large. It was preferable to use the special powdered form. It was also advisable to use ferro-chromium with a higher carbon content, because it was more easily crushed and the carbon gave a lower melting point. This ensured less trouble in distributing the chromium in the iron.

Author's Reply.

Replying to the discussion, Professor Hanson said he had no experience of nickel and chromium in malleable iron, but chromium did not strike him as a very suitable metal for alloying purposes with malleable, because of the stabilising effect of carbide, which was so pronounced. He was not so sure about nickel. Nickel would assist graphitisation, and to that extent would be good; and it would be retained in solution in the finished casting, and increase its strength. But there was a danger that in the presence of very low silicon it might introduce a stabilising effect on carbon below the critical range. Therefore it might not be suitable for black heart purposes, but it might possibly find application in the white heart process. Regarding unsoundness, he should not suspect nickel for any responsibility. Their experience was entirely in the opposite direction. Nickel additions to white iron which was unsound produced an improvement and removed the blow holes. As to the effect of nickel on graphite structure with the silicon unaltered, their own results had confirmed the investigations of American workers. This was that, generally speaking, nickel additions up to 2 per cent., or a little higher in some cases, showed a definite action in refining graphite; but beyond 2 per cent. these additions coarsened it. Hence, for all ordinary small additions of nickel to grey iron they could rely on nickel not to coarsen the graphite, but usually to refine it. They could not get the full value of nickel additions if the grain was open, and it was preferable to lower the silicon to secure the maximum benefit. Even if this was not done, they still gained an advantage by matrix hardening.

Continuing, Professor Hanson touched on losses, declaring that when alloys were put through the cupola there was no loss whatever of nickel, though if the cupola was run badly they might find the distribution irregular. Neither did they lose nickel when added in the ladle, nor in remelting scrap. Chromium losses were rather variable, ranging in some cases up to 30 down to 10 per cent., particularly when worked from the cupola. In the ladle they had experienced varying results, but as a rule they had noted very little loss. In the finely divided form great care must be taken to prevent the chromium dust getting into the cupola, otherwise there would be loss, and there was also danger of loss if the alloy was added in large pieces, especially when a low-carbon ferro-chromium was used. It would not always dissolve, and gravitated to the bottom of the ladle. With reasonable precautions not more than a 10% loss need be incurred in the ladle.

Institute of British Foundrymen.

LONDON JUNIOR SECTION.

The London Junior Section opened its third Session on Friday, October 26, with a meeting held at the offices of The Foundry Trade Journal, 49, Wellington Street, Strand, W.C.2, when the new Chairman, Mr. F. C. Cummings, gave an address.

In thanking the members for the honour which they had accorded him in making him their chairman for the present session, Mr. Cummings said he could only hope that his year of office would be as successful as had been that of their past-chairman, Mr. P. Ellis. He would promise to do his best, and hoped that the members would support him by turning up at the meetings in large numbers.

It was the duty of each one of them to acquire as much technical knowledge as possible, and it was for this purpose that the Institute of British Foundrymen was formed. It was now possible (as could be seen from the success of the Institute) for the foundry man to understand a few of the difficulties of the patternmaker, and *vice-versa*, and for the metallurgist to understand the difficulties of both.

During the last few years the foundry trades had been undergoing a rapid change with the introduction of machinery, although, in spite of all these changes, a fully skilled man was still a vital necessity, and there would soon be a very serious shortage of such men owing to a reluctance amongst the younger men of to-day to enter the engineering trades.

The chairman then gave a short review of the difference in the training of apprentices from the time when first conditions demanded apprentices for the carrying on of trades.

In the Middle Ages the most successful form of industrial organisation was the craft guilds. There were three classes of workers in the craft, namely, apprentices, journeymen and masters, and through these grades all members had to pass, except in some cases when the journeyman stage was omitted.

Apprenticeship, which lasted for terms varying in different crafts, but usually about seven years, comprised not merely a technical training but also a social training in manners and morals. The apprentice would live in the master's house, usually being treated as one of his family.

A journeyman was an apprentice who had completed his training. He was expected to serve with a master for two or three years so as to get experience and a little money before setting up on his own account.

Finally, he was formally admitted into the craft as a master in payment of a fee, or sometimes on presentation of a "master piece" to prove his efficiency. There was no difference in the social status of masters and apprentices and journeymen.

These craft guilds had councils, which made rules as required, and appointed overseers to inspect workshops, etc.

At the present day there was not a keenness among young men to enter into a term of apprenticeship in the foundry trade, in fact there was a serious shortage of suitable applicants.

He personally must say that he felt that the foundry trades had not, until recently, offered the same prospects as had other branches of industry, and even now there was no recognised diploma for a young man who was thoroughly conversant in general foundry practice and who could show diplomas in theoretical training. The two combined meant a very useful man, and one who was of vital necessity to the industry at the present time.

It was noticeable, also, that even with all the different schemes in force at the present time, a great many young men, directly they have finished their apprenticeship, turn their attention to other occupations rather than follow the trade they have been taught. He (the speaker) was afraid that until the foundry trade could offer the same prospects as other trades it would always experience a shortage of apprentices of the right type.

An interesting discussion then took place among the members, after which a hearty vote of thanks to the Chairman was proposed by Mr. P. Ellis, and seconded by Mr. L. H. Howell.

The Mechanical Properties of Cast Steel at Elevated Temperatures.

Experiments have been made by A. Pomp* in order to investigate the behaviour of cast steel at temperatures up to 500 deg. C. The chemical compositions of the different samples used in these experiments are recorded in Table I. Table II gives some data concerning the manufacture of the steels. The samples B, C, J, L, and M were cast vertically, the others horizontally. The microscopic examination showed that with the steels A, B, C, D, F, J, and K the ferrite and the pearlite were evenly distributed; in the samples E, G, H, L, and M the pearlite formed a network around the ferrite crystals indicating that the samples had been annealed in the critical range. From the cast samples test bars for the tensile test and the notched bar test were prepared according to Fig. 1; the dimensions are given in millimetres. The following properties were examined:—Elastic limit (permanent elongation of 0.01 and 0.03 per cent.), 0.2 limit (permanent elongation of 0.2 per cent.), yield point (as revealed by the stress-strain diagram), tensile strength, elongation on 3.94 in., contraction of area, impact strength.

TABLE I.—*Composition of Steels Used.*

Steel.	C.	Si.	Mn.	P.	S.	Ni.	Cr.
A	0.12	0.25	0.32	0.011	0.023	0.04	0.11
B	0.14	0.29	0.45	0.016	0.037	0.07	0.19
C	0.28	0.37	0.74	0.036	0.028	0.17	0.15
D	0.53	0.22	0.28	0.058	0.046	0.03	0.12
E	0.26	0.38	0.85	0.016	0.012	0.21	0.15
F	0.18	0.19	0.77	0.064	0.043	0.06	0.12
G	0.24	0.24	1.07	0.079	0.068	0.06	0.09
H	0.17	0.23	0.67	0.089	0.076	0.04	0.08
J	0.20	0.84	0.90	0.034	0.033	0.14	0.17
K	0.10	0.92	0.74	0.051	0.039	0.06	0.20
L	0.16	0.33	0.35	0.016	0.036	1.05	0.27
M	0.18	0.33	0.45	0.015	0.027	2.68	0.18

Elastic Limit.

The experiments were made with a 50-ton capacity Amsler testing machine, into which an electrically heated furnace was installed. To ensure a uniform distribution of temperature along the whole test bar the heating was performed in an oil bath up to 200 deg. C., and in a salt bath (equal parts of KNO_2 + $NaNO_3$) for temperatures above 200 deg. C. The measurements were made with the Martens reflex extensometer. At room temperature the 0.01 limit was found between 11.23 and 19.12 tons per sq. in. With the increasing temperature a continual lowering of the limit takes place; at 500 deg. C. the values were between 3.18 and 7.11 tons per sq. in. At room temperature the 0.03 limit is slightly above the 0.01 limit; the lowering occurs more slowly; at 500 deg. C. the values are by about 0.64 to 1.27 tons per sq. in. higher than that of the 0.01 limit; with the samples C and J this difference is 2.54 tons per sq. in. A comparative summary of the test values at room temperature and at 500 deg. C. is given by Fig. 2.

0.2 Limit.

At room temperature this limit is only slightly above the elastic limits (between 11.81 and 19.55 tons per sq. in.); with the increasing temperature the sinking occurs more slowly; at 500 deg. C. the test values are between 4.96 and 10.48 tons per sq. in., that is 42 to 67 per cent. of the values found at room temperature (below 50 per cent. with the samples A, B, F, G, L, and M). The highest test values were found in the samples high in manganese: C (10.73 tons per sq. in.), E (10.28 tons per sq. in.), and I (10.48 tons per sq. in.). The low value (6.22 tons per sq. in.) of sample L containing 1.65 per cent. Ni is remark-

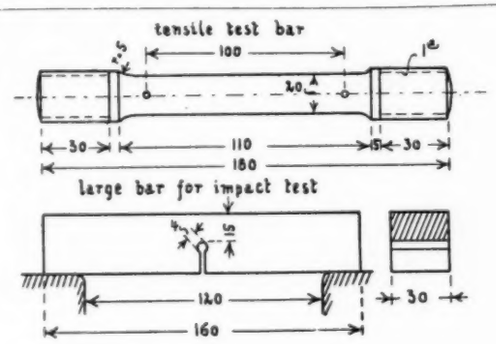


Fig. 1.

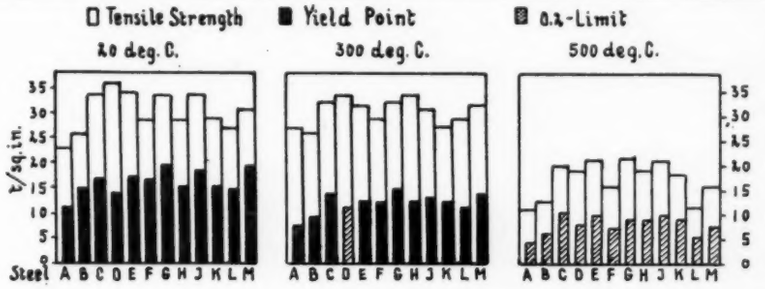


Fig. 3.

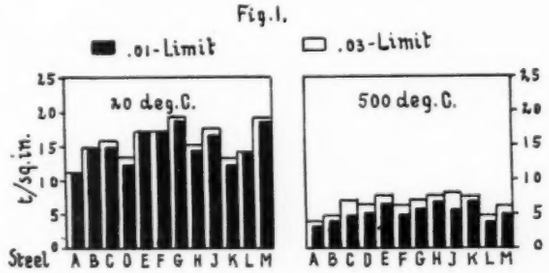


Fig. 2.

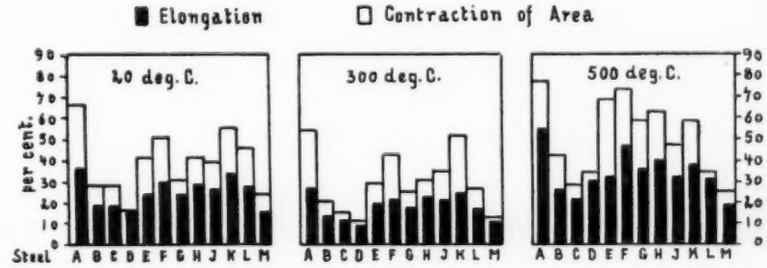


Fig. 4.

* "Stahl und Eisen", 1928, No. 38, pp. 1321-30.

TABLE II.—*Characteristics of the Steel Samples Used.*

Steel.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.	L.	M.
Speciality of Analysis.	C = 0.12	C = 0.14	C = 0.28 Mn. = 0.74	C = 0.53	C = 0.26 Mn. = 0.85	P+S = 0.107	P + S = 0.147	P + S = 0.165	Si = 0.84	Si = 0.92	Ni = 1.05	Ni = 2.68
Furnace.	Open hearth.	Open hearth.	Open hearth.	Open hearth.	Electric.	Bessemer converter.	Bessemer converter.	Bessemer converter.	Open hearth.	Open hearth.	Open hearth.	Open hearth.
Capacity tons	25	5	28	25	6	2	2	2	28	18	5	5
Lining.	Basic.	Basic.	Basic.	Acid.	Basic.	Acid.	Acid.	Acid.	Basic.	Basic.	Basic.	Basic.
Casting Temperature Deg. C.	1,550*	1,500 to 1,620	1,410	1,650*	1,605	1,600*	1,650	1,600*	1,400	1,800*	1,580 to 1,620	1,580 to 1,620
Heat-Treatment.	5 h. at 900 to 910 deg. C.; cooled in the furnace.	4 h. at 820 deg. C.; cooled in air-tight muffle.	8 h. at 920 deg. C.; cooled in the furnace.	1 h. at 940 deg. C.; cooled rapidly to 750; then slowly.	5 h. at 910 deg. C.; cooled in the furnace.	4 h. at 900 deg. C.; cooled in the furnace; doors sometimes open.	As steel D	As steel F.	8 h. at 930 deg. C.; cooled in the furnace.	1 h. at 910 deg. C.; cooled in the furnace.	As steel B.	As steel B.

* Estimated.

able. The 0.2 limit and the elastic limits are profoundly influenced by the chemical composition; a strict relationship, however, could not be established.

Yield Point.

The stress-strain diagram was automatically recorded by the testing machine. The increase of load was 0.127 tons per sq. in. per second until the yield point was attained. The yield point could clearly be seen in the diagram at temperatures up to 200 deg. C. At 300 and 400 deg. C. it was not discernible, but with some samples, at 500 deg. C. the diagram did not show any irregularity. With the increasing temperature a continual sinking of the yield point occurred. It is profoundly influenced by the chemical composition, especially by the carbon content, which increases the yield point; manganese and silicon act in the same sense. The highest test value (19.62 tons per sq. in.) was found with sample G containing 1.07 per cent. of manganese. Phosphorus and sulphur have no influence; the same is the case with 1 per cent. Ni; the test value of sample M containing 2.68 per cent. Ni was 19.38 tons per sq. in.

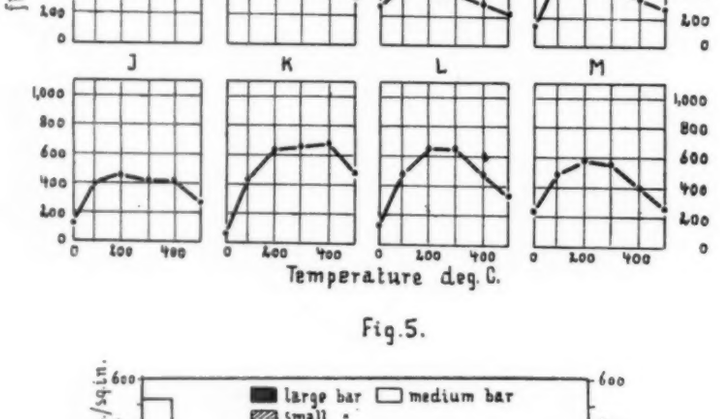


Fig.5.

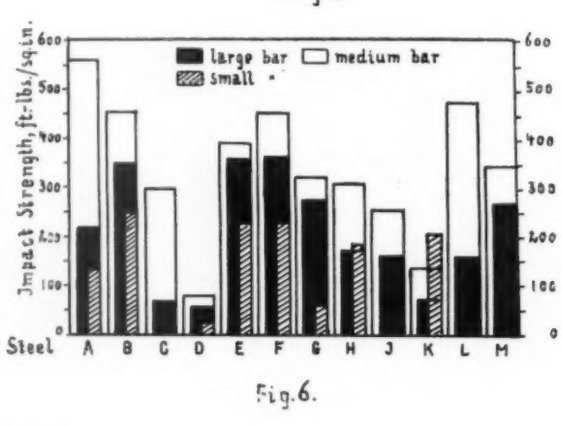


Fig.6.

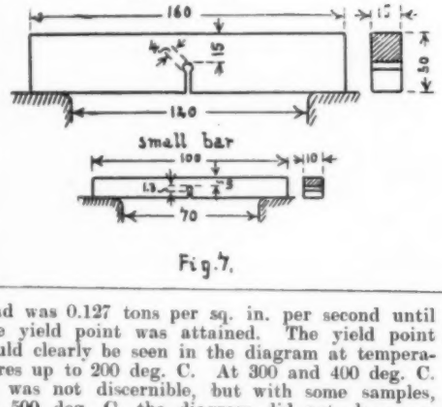


Fig.7.

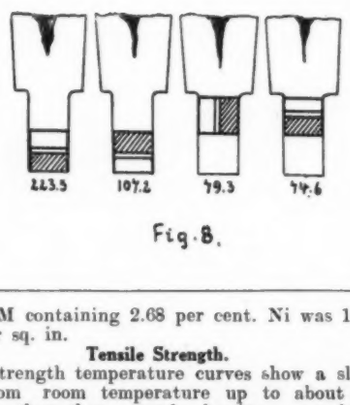


Fig.8.

Tensile Strength.

The strength temperature curves show a slight fall from room temperature up to about 100 deg. C.; then they ascend, showing a maximum value at from 200 to 300 deg. C.; then they fall off rapidly. The tensile strength is increased by carbon and manganese. At 500 deg. C. the test values are equal to 45 to 68 per cent. of that found at room temperature. The high test values of the samples G and H (65 and 68 per cent.) high in phosphorus are remarkable. The lowest value (45 per cent.) was found with sample L containing 1.05 per cent. Ni. A comparative summary of the values found at room temperature, 300 and 500 deg. C., is shown in Fig. 3.

Elongation and Contraction of Area.

The elongation temperature curves show a minimum value at between 200 and 300 deg. C. The values of the samples B and M at room temperature were below that given by the German specifications. As these samples had been poured vertically, it was thought that the pouring method was to be blamed. Further experiments, however, showed that the pouring method had no influence upon the test values. The contraction curves show about the same course as the elongation curves. The test values found at room temperature, 300 and 500 deg. C., are recorded in Fig. 4.

Impact Strength.

The test bars were kept at definite temperatures for half an hour, and then broken in a Charpy machine. The test values of the different samples are shown in Fig. 5. The highest values at room temperature were found with the samples B, E, and F. Between 100 and 300 deg. C. the mild steels are superior to the other samples. By annealing sample K at 1,030 deg. C. for two hours the test values (tensile and impact strength) were not changed. Further experiments showed that the dimensions of the test bar have a great influence upon the strength. This can be seen from Fig. 6, where the results obtained with the large test bar (Fig. 1) are compared with that obtained with the medium and the small test bars (Fig. 7; dimensions in millimetres); the medium test bar gives the highest values. Furthermore, the impact strength depends upon the location of the test bar in the casting. Fig. 8 shows some castings of steel K; the bars were taken as illustrated; the accompanying numbers give the impact strength in ft.-lbs./sq. in. (average values of 2 to 3 experiments).

Nottingham, Wake Up !

Appeal from the Institute of British Foundrymen.

It is somewhat surprising to find that there are so few people in Nottingham who are members of the East Midlands Section of the Institute of British Foundrymen. There is no reason at all why this should be so, as the honorary secretary (Mr. H. Bunting), of Derby, has done, and continues to do, everything that will promote interest. When a local representative of The Foundry Trade Journal made inquiries with regard to the membership of the branch, he was quite surprised to learn that there were so few members from Nottingham, and from now onwards an urgent appeal goes out to the men who live in the lace city to wake up and join this chartered organisation, which, since it was founded, has done some excellent work, and, moreover, helps to create a better feeling among the foundrymen in the towns which it embraces. Derby, Leicester and Loughborough are well represented, and it is very unfortunate that this cannot be said of Nottingham. At present the meetings of the branch are held in these towns, but Nottingham is unable to claim this distinction, because of its insufficient membership. As soon as Nottingham does become an important town, so far as the branch is concerned, meetings will be arranged there.

The programme for the present session excludes meetings in Nottingham and Derby, Leicester and Loughborough claim the whole, but no doubt, if Nottingham does wake up, Mr. H. Bunting, and the officials of the branch, would perhaps consider the holding of an additional meeting so as to include Nottingham. Any information that is required with regard to membership can be obtained from Mr. H. Bunting, of 82, Otter Street, Derby.

Methods for Evaluating Properties of Cast Iron.*

The discussion on the recent lecture by Mr. J. E. Hurst, given to the London Branch of the Institute of British Foundrymen, showed in no uncertain manner that more thought has been given to this subject than is generally thought. We give an abstract of the main points raised.

MR. WESLEY LAMBERT (President-Elect of the Institute), after expressing indebtedness to Mr. Hurst for presenting so comprehensive a review of the various formulæ and diagrams, said that in earlier days, when he was more directly interested in cast iron than he is to-day, he had made use of a formula, not referred to by Mr. Hurst, which took into account the effect of manganese, and he believed phosphorus also. Unfortunately, at that time the microstructure of cast iron was not examined so critically under the microscope as it is to-day, but, so far as one was able to judge, this early formula was fairly reliable. We are certainly indebted to those pioneers who attempted to put forward something in the way of either formulæ or diagrams.

The examination of a large group of analyses of cast iron was rendered difficult by the multiplicity of figures, whereas by the use of a diagram the constituents of an iron of a particular composition can more readily be determined. He quite agreed with Mr. Hurst that anything based merely on the summation of the total carbon and the silicon content was very weak, and for that reason a diagram such as the Thrasher diagram represented a great advance on the earlier efforts. It had occurred to him that it would be possible to construct a diagram with a sliding panel to correct for thickness of section. He asked if this had been done.

MR. HURST said it had not, but it might be done with advantage.

MR. LAMBERT added that with such a sliding panel one could readily correct for differences in thickness of the iron, and it seemed to him that with the addition of a sliding panel the diagram would serve a very good purpose. To-day he was more particularly interested in manganese bronze, and that, like cast iron, was a very complex material, and anything in the way of determining the microstructure solely by means of diagrams or a simple formula was out of the question. Thanks, however, to the researches of Guillet, one was able, by means of a series of simple calculations, to determine fairly accurately the microstructure of these complex brasses, but, unfortunately, the same method of calculation is not readily applicable to cast iron.

MR. H. C. DEWS, in a tribute to Mr. Hurst for his interesting and instructive review, said that it must lead metallurgists to think a great deal about these diagrams and formulæ, and to crystallise many ideas which might have been more or less nebulous in their minds. He agreed with Mr. Lambert that we were in debt to the early pioneers who had the courage to attempt these diagrams, even though subsequent research had shown how fallacious were most of their conclusions. It was, perhaps, gratifying to know that the formulæ and the diagrams which were of German origin were the ones which Mr. Hurst had most severely condemned. Lately they had had before them a repletion of German work, and there had been a tendency in the British technical Press to laud rather too highly a good deal of that work. They all appreciated much brilliant work that had been done by German investigators, but at the same time some very specious work had been published in Germany, not only lately but for a good many years. They should not get into the habit of overlooking the work of British metallurgists in favour of foreign work. Mr. Hurst's reference to the straight-line law was worthy of the very deepest consideration by metallurgists, foundrymen, and all who studied technical questions. There was too great a tendency to try to conform results to a straight-line law. Scientists knew full well that practically no natural phenomena obeyed a straight-line law. In considering specific heat, thermal conductivity or almost any other property of materials they found the variation with temperature, etc., to be not linear but parabolical, and they should try to remember that when considering diagrams with straight lines. Mr. Hurst had warned British metallurgists to be wary of relationships based on the summation of total carbon and silicon contents. It was a coincidence that in a Paper presented to the Iron and Steel Institute this autumn by a British metallurgist—and he believed the Paper had the backing of a group of British cast-iron metallurgists—there were a number of diagrams which were based entirely on total carbon and silicon contents. In view of what Mr. Hurst had said, it would be interesting to hear the view of those associated with this Paper.

MR. A. GIBBS, having spent a good deal of time that afternoon trying to understand a diagram in a Paper in which the total carbons and silicons were grouped together, and having failed to appreciate its import, agreed heartily with the remarks of Mr. Hurst, Mr. Lambert, and Mr. Dews in regard to this matter. In the Paper by M. Louis Piedbœuf, which was the Belgian exchange Paper of 1926, the Maurer diagram was included. On the horizontal axis was given the thickness of the casting and on the vertical axis the silicon, and there were not the discrepancies which Mr. Hurst had referred to. The diagram in M. Piedbœuf's Paper was easy to understand, and therefore we ought not to agree to the adding together of the total carbon and silicon. With regard to the formula from Hütte, to which Mr. Hurst had referred, he suggested that it was used a little more than Mr. Hurst had seemed to imply. The figure of 4.3 was given, and there were figures to prove that something was going to occur above 4.3 which would not occur below or at 4.3. Above 4.3 apparently there existed a different state of affairs altogether, and it would have been rather enlightening if Mr. Hurst had worked out some further figures; he had given the maximum and the minimum silicon in one case, and it would have been interesting if he had reversed it and had given the maximum silicon and the minimum of carbon. If that had been done he felt sure there would have been some variations in the results. Certainly we should not condemn Maurer for his attempts to produce a useful formula, for there was no doubt that he had done some very fine spade work.

DR. M. L. BECKER, referring to Maurer's diagram—which he believed was brought out considerably later than Thrasher's diagram, the date of the latter being about 1915—said he did not think it mattered very much, from the point of view of the use of the diagram, if one did add the total carbon to the silicon. If, for instance, instead of plotting the sum of the two, we plotted the product, we should then get a diagram consisting of a series of curves instead of straight lines. He believed it would be found that if these two diagrams were plotted from the same data (the one diagram showing the sum and the other the product of the total carbon and silicon plotted against thickness of section), the type of fracture determined from either would be practically the same. To carry the matter a little farther, if one plotted $\sqrt{\text{total carbon x silicon}}$, one would obtain a further diagram consisting of curves.

There again one would obtain similar results. When working within a limited range of composition, as specified, no matter whether one took the sum, product or square root of the product of the total carbon and silicon contents, one would not be very far wrong provided one used the appropriate form of diagram. He quite agreed, however, that there was no real reason why we should say that irons having the same sum total carbon and silicon should necessarily graphitise at the same rate.

Vote of Thanks.

The BRANCH-PRESIDENT, proposing a vote of thanks to Mr. Hurst, expressed indebtedness to him for having so kindly consented to lecture to the Branch, though at great inconvenience to himself. Further, his Lecture gave to the members a great deal of food for thought, and they were all very grateful to him for all he had done for them.

MR. V. C. FAULKNER (Past-President of the Institute), seconding the vote of thanks, said that the Institute as a whole was deeply indebted to the lecturer for his ready willingness always to place at their disposal his great metallurgical and practical experience. He wondered whether it would not be better for the practical foundrymen to utilise the list of compositions as given by Mr Field for the various applications of cast iron, or an earlier one published in THE FOUNDRY TRADE JOURNAL, as these were based on wide practical experience, instead of memorising a factor which had later to be translated into percentages, but still leaving the choice of at least three elements to the discretion of the foundrymen.

The vote of thanks to Mr. Hurst was carried with acclamation.

Author's Reply.

MR. HURST, after expressing his appreciation of the vote of thanks, and his pleasure in having another opportunity to lecture to the Branch, said that apparently most of those present had given a good deal of thought to the diagrams he had referred to, and appeared to concur generally in the conclusions he had expressed. He believed that what was giving the metallurgists considerable concern in connection with cast iron to-day was the fact that whilst the old method of working strictly and rigidly to fracture had disappeared, and he believed had been definitely displaced by working to composition, there was difficulty in reconciling the fact that the same composition does not always give the same results. Mr. Hurst disclosed an example of two piston-ring drums identical in shape, thickness and chemical analyses, differing only in diameter. These two castings showed very great differences in mechanical properties.

The vital point, however, upon which metallurgists must concentrate for the benefit of foundrymen was that of explaining why a casting made in an Italian foundry did not give the same results as one made of the same composition in a French foundry, or why a casting made in Peterborough did not give the same results as a similar casting of the same composition made in Sheffield.

MR. W. LAMBERT said in the case of piston rings one had to consider the shaped article rather than the metal *per se*, and he asked Mr. Hurst if he was satisfied that the state of internal stress in each casting was the same. All the figures which had been given were, of course, influenced somewhat by the initial state of stress in which the metal of the casting happened to be as a result of the rate and method of solidification of the metal. Nothing had been said with regard to the microstructure, nor had anything been said as to whether when rings taken from each of the two piston pots were machined and split each and every ring sprang open or closed in to a like degree.

MR. HURST replied that there was nothing abnormal whatsoever. It was part of the procedure in all the piston-ring tests to note any opening or closing or any movement of the gap formed immediately on cutting. In the case of the rings he had exhibited there was no sign of internal stress whatever. The difference in test results was such as would not generally be detected in ordinary foundry testing, because ordinary foundry testing, in his view, was not sufficiently delicate. If one found half a cwt. difference on a transverse bar in the foundry, one did not worry much about it. It was considered as an "as-cast" bar, and the dimensions were not strictly accurate as in the case of piston-ring testing.

He mentioned all this to show that the diagrams did not take into consideration many of the vital factors which went to make up the properties of cast iron, and to draw attention to the fact that in spite of our notions on control by composition there is yet some other factor we have not traced, and which composition does not thoroughly explain.

* Evaluation of the Properties of Cast Iron from Formulæ—Page 281.

A Simple Casting with Some Unique Features.

By J. McLachlan.

There are some castings which, simple in design and apparently without any features that should cause difficulty in the foundry, are yet not as easy as they look. Some care has to be taken in making a casting such as is shown in Figs. 1 and 2, otherwise it will come out of the sand badly warped. The writer was responsible for such a casting some years ago, and in modified forms it is not an unusual type. There are moulding difficulties because the metal of the centre boss is so much thicker than the plate, and, owing to this, an unequal contraction results, and there may be bad warping of the plate.

In the construction of the bottom plate several widths of timber can be employed, these being fastened together with battens inset to half the thickness, but a better way than this is to make the plate in the form of an open half-lapped frame, and especially so if more than one casting is required.

It may be well to describe briefly the actual construction of a suitable half-lapped frame (Fig. 3). With careful marking of the joints and careful finishing subsequently with saw and plane less than $\frac{1}{16}$-in. should be necessary for facing. It should scarcely be necessary to gauge the frame thickness; the edges of sides and ends ought to be finished square and parallel and centre lines marked on both faces.

One of several different methods may be used in building the centre boss. One method is to fit the ribs across the plate diagonally and build up with blocks fitted between the ribs. A pattern, thus made, would be strong, but it would be extremely heavy and costly, not so much because of the amount of timber used, but owing to the labour involved in building and shaping the several blocks. It is undoubtedly better to make the boss separately and fit the ribs against it. The question then arises as to whether a skeleton boss would be satisfactory.

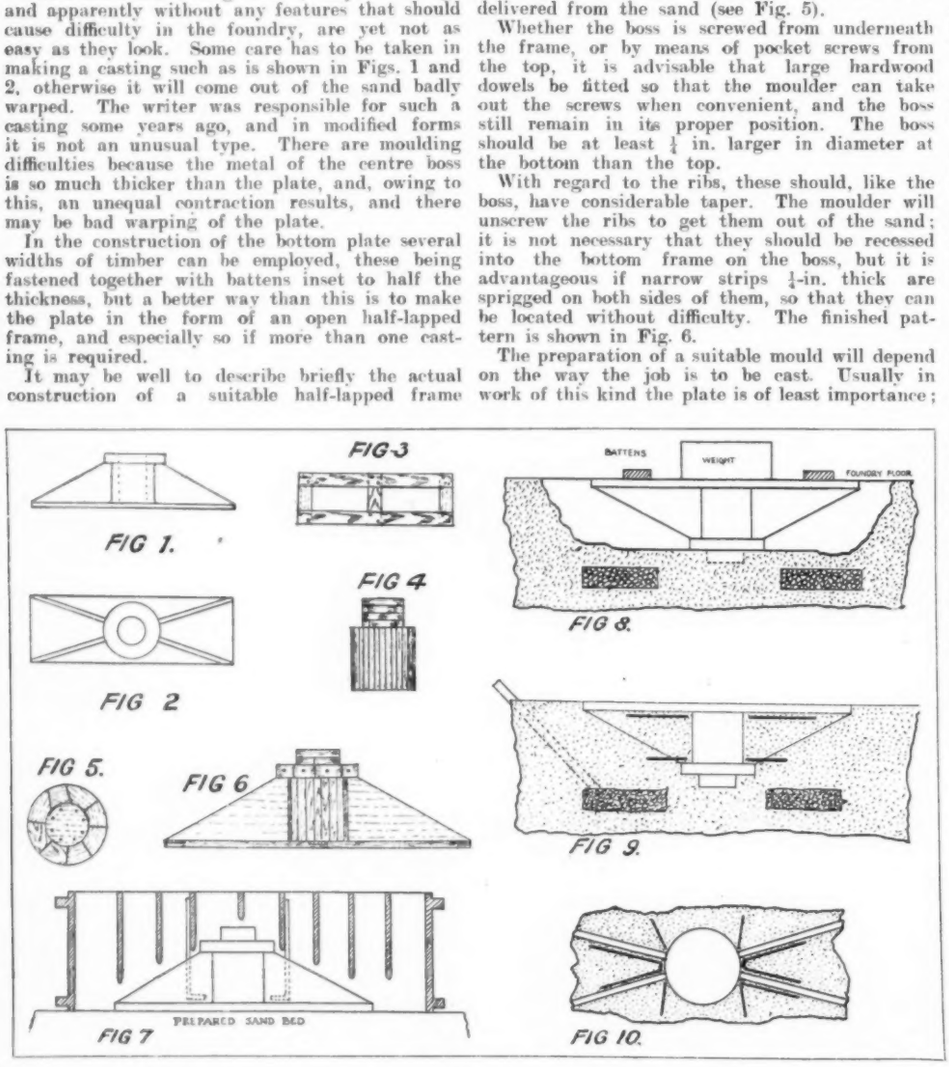
A very suitable pattern for the boss is shown in Fig. 4. As will be observed, it consists of a lagged barrel with a print, segmentally built, screwed on the top.

If a one-off pattern were being made, it would be quite satisfactory to make the print of solid timber. Such a barrel can be built as quickly as a skeleton. The flange is made in as many parts as are necessary, in order that it can be drawn into the mould when the boss has been delivered from the sand (see Fig. 5).

Whether the boss is screwed from underneath the frame, or by means of pocket screws from the top, it is advisable that large hardwood dowels be fitted so that the moulder can take out the screws when convenient, and the boss still remain in its proper position. The boss should be at least $\frac{1}{4}$ in. larger in diameter at the bottom than the top.

With regard to the ribs, these should, like the boss, have considerable taper. The moulder will unscrew the ribs to get them out of the sand; it is not necessary that they should be recessed into the bottom frame on the boss, but it is advantageous if narrow strips $\frac{1}{4}$-in. thick are sprigged on both sides of them, so that they can be located without difficulty. The finished pattern is shown in Fig. 6.

The preparation of a suitable mould will depend on the way the job is to be cast. Usually in work of this kind the plate is of least importance; the flange, being uppermost in use and requiring to be machined, is given preference with regard to soundness and is consequently cast down.



The most satisfactory way to prepare the mould is undoubtedly by the turnover method. Owing to all the work being on one side of the plate this method gives better facilities of access for ramming purposes, rodding and incidentally vent, particularly between the webs. Adopting this method it is a comparatively simple operation to prepare a level bed upon which the pattern can be laid, and about which a suitable box is located, as indicated in Fig. 7. Many moulders make use of gaggers to reinforce the sand in pockets such as are formed in this instance, but, since it is a drag part and not a cope that is being made, the sand can either be rodded parallel to the plate and radiating from the boss, or grids may be used and give more satisfactory support. Ribs and flange sections need to be loosened during the process of ramming, and when the drag has been completed care should be given to vent before turning over preparatory to proceeding with the cope.

Although turning is preferable it is rarely indeed that a suitable box is available for such a job, and since it is more in the nature of a one-off job, the foundry floor would invariably be used. This involves bedding-in, and, though not essential, it is advisable to prepare a bed for the flange. Preparatory to making this bed, arrangements should be made for releasing air and gases from the sand between the ribs, and it is profitable to make use of under chambers as shown in Fig. 8.

When the bearance for the flange has been prepared the pattern can be located on it, the print being bedded in, as indicated. Battens can be attached to the top of the pattern to give a bearance on the floor level, and a weight used to maintain its position. The flange segments can be released and simply laid round the boss; sand being rammed against them will keep them in their relative positions. It is much more awkward to rod the sand pockets by this method but it is very necessary. The most convenient form is that shown in Figs. 9 and 10. The use of grids is not very satisfactory, owing to the difficulty of ramming after they have been placed. When the ramming has been completed and the weight and battens removed from the pattern a cover box is located and provision made for running the job.

The variation in the thickness of metal creates difficulties. The bottom flange is fairly heavy, and the boss section is thicker than both ribs and plate. With a dry-sand mould chills about the back of the flange and at intervals about the outside of the boss would reduce much of the difficulty by causing more regular cooling, but green-sand moulds are frequently used for such castings, and chills in such moulds are a questionable improvement.

Steam condensing on the chills is the cause of much trouble, and the blowholes produced are a frequent cause of waster castings. Many efforts are made to reduce the condensation which takes place, with varying degrees of success; brushing oil over the faces of the chill just before closing the mould is probably as successful as any. With a green-sand mould it would suffice if, after casting, the metal about the centre of the plate is uncovered and as much of the core removed as possible. Runners should be arranged near to one end, and running direct into the two ribs.

A Hammer Head.

By H. Littlehales.

Every good craftsman takes some degree of interest in his tools. A favourite chisel, a gauge, a plane, or any other tool which has long been of tried service becomes in course of time an old friend. Many patternmakers will agree that possibly there is a greater personal tie between the paring chisel than any other tool. Rarely, however, does the hammer receive any attention. Its nature certainly does not call for such, and it is very rarely indeed that a hammer of any other than the plainest surfaces is to be met with, and such has been the case, we know, for centuries. To every rule there is, however, an exception, and the hammer-head shown in our illustration displays a head of considerable beauty, and certainly of a very unusual design. We do not, it is said, at all times find use and beauty running together, but here is an example of the union of both. This head is of bronze. It is large, being more than 6 in. in length. It will well repay a careful examination.

An Antique Hammer Head.

For our photograph we are indebted to the Director of the Victoria and Albert Museum.

Some Notes on Non-Ferrous Casting Alloys.*

By Wesley Lambert (President-Elect of the Institute of British Foundrymen).

In the course of his remarks, MR. LAMBERT said that few, if any, of the elementary metals, in the unalloyed form, were cast into intricate shapes. The non-ferrous casting alloys with which the industry is chiefly concerned may be summarised as follows:—(1) Copper-tin base alloys, covering the true bronzes and alloys of the gunmetal and phosphor-bronze type; (2) copper-zinc base alloys, comprising the common brasses and the complex brasses of the manganese bronze type; (3) copper-aluminium base alloys, including the simple and the complex aluminium bronzes; (4) copper-lead base alloys, embracing a wide range of bearing and of acid-resisting metals; (5) aluminium-base casting alloys; and (6) whitemetal alloys of various categories, such as white brass, pattern-plate alloys, shaft-lining metal, etc.

The author has already, at Newport and other centres, dealt with the copper-zinc casting alloys, including manganese bronze, in considerable detail, and therefore he proposed to confine his remarks on this occasion to the copper-aluminium bronzes and the copper-tin group of alloys—the true bronzes—the latter group including as it does the various types of red brass, gunmetal and phosphor-bronze alloys, which are in most general use in the non-ferrous sections of those foundries which can be considered as representative.

In general, in bronze casting mixtures there is seldom occasion to increase the content of tin beyond 10 per cent. Special castings, such as bells and those which have to resist abrasive wear, such as slide valves, gear wheels, bearers, piston rings, etc., may, however carry up to 17 per cent. of tin. The highest percentages of tin are confined almost entirely to bell-metal mixtures.

Admiralty Gunmetal.

Admiralty gunmetal may be regarded as a good all-round stand-by mixing for gunmetal castings, whether large or small, but it demands experience, and to cast successfully some of the castings called for in this alloy is not a simple task or one to be taken on without due consideration. Admiralty gunmetal enjoys such a popularity among engineers that it is perhaps not too much to aver for this alloy that, of all alloys, its composition is the best remembered, and the figures 88/10/2, denoting the percentage content of each of the three metals constituting the mixing, are rolled off from the tongue more readily than one repeats his own telephone number. The wholehearted popularity accorded to Admiralty gunmetal by the engineer is more grudgingly accorded by both the metallurgist and the foundryman. All foundries are not equally happy together in their experience with Admiralty gunmetal as a casting metal, and unauthorised liberties, such as an increase in the percentage of zinc to 4 per cent., or an addition of lead to the extent of 1 per cent. or more, etc., are often taken in order to cover inability to make successful castings in the recognised mixture. The addition of a small percentage of nickel, not exceeding 1 per cent., however, will have a tendency to give a closer metal and additional strength in a casting.

Phosphor Bronze.

Phosphor bronze, in common with other special bronzes such as vanadium bronze, titanium bronze, manganese bronze, etc., includes alloys in which the distinctive element, from which the particular bronze derives its name, has been introduced into the alloy solely as a scorifying or scavenging agent, and it may be present in the resulting alloy only to the extent of "traces," analysis sometimes failing to detect even traces of such elements. Mention is made by Thurston of phosphor bronze with as high a phosphorus content as 4 per cent. In the lecturer's experience, covering the examination of a great many cast phosphor bronzes, 2 per cent. of phosphorus figures as the highest content of this element, and in the majority of cases the figure was well under 1 per cent. Mr. A. Philip, Admiralty Chemist, as a result of having tabulated the composition and mechanical tests of a very large number of castings in phosphor bronze, proposed a chemical specification for this alloy in which the maximum percentage of phosphorus is 0.6, and the minimum figure 0.3 per cent.; the tin content being 7.4 to 9.7 per cent. A tensile strength of not less than 17 tons per sq. in. and an elongation of not less than 20 per cent. on a 2-in. acting length is mentioned by Philip in this connection. The Admiralty specification calls for an alloy having a composition of copper 90 per cent., tin 9.7 per cent., and phosphorus 0.3 per cent. In those cases where a high degree of resistance to wear and low coefficient of friction combined with strength are the most desirable properties, the content of tin may with advantage be increased over the Admiralty percentage, and the phosphorus may be raised to 1.0 per cent., or slightly over. Such bronzes fall within the category of the bearing metals, and the microstructure is found to conform to the recognised structure of a bearing metal inasmuch that a hard constituent segregates out, forming hard particles which, more or less uniformly distributed, are found embedded in a softer matrix. The Air Board specification, for bearings in phosphor bronze, calls for a phosphorus content in the ingot metal of 0.8 to 1.2 per cent., and in the actual casting 0.5 to 1.0 per cent., the percentage of tin being 10 to 13. It is obvious from the above statements that it may be somewhat misleading to describe as phosphor bronze those alloys in which phosphorus has been used merely as a deoxidiser, and in which only traces, if any, of this element can be found by analysis. A distinction should be made between phosphorised bronzes and genuine phosphor bronze. For important castings, a composition closely approximating copper 89, tin 10.5, and phosphorus 0.5 per cent. is recommended. The mechanical properties of an alloy of this mixing should show an ultimate strength of 18 to 22 tons per sq. in, and elongation of 15 to 20 per cent. on a 2-in. acting length, and a Brinell hardness of 80 to 90. The specific gravity will be round about 8.6.

Phosphor bronze is nowadays invariably made by compounding together copper, tin, and a rich phosphorus-bearing alloy, such as phosphor-copper or phosphor-tin. Either phosphor-copper carrying 10 to 15 per cent. of phosphorus or a phosphor-tin with a phosphorus content round about 3 to 5 per cent. being the alloys in most general use.

The general foundry procedure to be adopted to secure sound castings in alloys of the gunmetal and phosphor-bronze type was very fully expounded; the lecturer throwing out many excellent practical hints.

Aluminium Bronze.

Passing on to the heavy alloys of the copper-aluminium group, the lecturer pointed out that aluminium-bronze is essentially an alloy of copper and aluminium, the copper being in the predominating quantity. Throughout a number of years, the most generally accepted proportion in which the two metals copper and aluminium have been compounded is that of the well-known ratio of 90 parts by weight of the former, and 10 of the latter metal; aluminium bronze made up from copper and aluminium in this proportion is still in use, to a limited extent, as a casting alloy, in a few foundries whenever high tenacity non-ferrous bronze is specified. A tensile strength of 32 to 35 tons per sq. in., with an elongation of 20 to 25 per cent. in a 2-in. acting-length is nowadays expected from well-run cast-metal. The elastic-limit should approximate round about half the breaking-load, and the reduction of area at the fracture should not fall short of 25 per cent. These figures when referred to those obtainable from properly-run manganese bronze will not show anything in favour of the aluminium bronze over the manganese bronze. It is, however, in a consideration of the behaviour of aluminium bronze under alternating or repeated stresses that the value of this metal for parts subjected to such stresses is made evident. Without going very deeply into the matter, it may be said without fear of contradiction that aluminium bronze is superior to manganese bronze in endurance of alternating stresses or resistance to fatigue. Putting this statement into a form in which the practical application of this desirable property of resistance to fatigue relates to engineering practice, one can affirm that an aluminium bronze may be subjected to stresses of an order little less than its ultimate strength, as determined by the ordinary tensile testing, and will be found to resist failure (fatigue), whereas manganese bronze when subjected to alternating or repeated stresses, can only be relied upon to resist failure under fatigue, provided the stress applied is within the elastic limit of the bronze as determined by a tensile test. The composition of commercial aluminium bronze of casting quality varies between somewhat wide limits, and in many cases the addition elements beyond the essential metals, copper and aluminium, bring the bronze within the category of the complex alloys. The more generally useful aluminium bronze alloys, in common with manganese bronze, in the normally cooled condition, also possess characteristic microstructure, inasmuch as the former exhibits either a single-phase structure or a duplex structure, that is to say, in the one case an all-alpha structure, and in the other case the alpha micro-constituent associated with a second constituent. Certain alloys of the aluminium bronze series are very susceptible to heat treatment, and the mechanical properties of such alloys may be improved or at least modified by suitable thermal treatment. It is perhaps as well that one should be reminded that, generally speaking, so far as the mechanical properties are concerned, thermal treatment has little or no material effect upon those alloys which, when slowly cooled, are found to consist wholly of the alpha solid solution. Alloys within the true alpha range are malleable hot or cold, whereas those with a high aluminium content—9 to 15 per cent.—are advisedly worked hot (600 to 1,000 deg. C.). It is as well to remember, however, that the higher the residual heat in the forged part the greater the liability to larger grain growth.

In the manufacture of straight aluminium bronzes (copper and aluminium) care must be exercised in selecting the constituent metals. Electrolytic copper and a good quality of aluminium are essential when the best results are desired. The usual percentage of aluminium is 10 to 12, and the latter figure should rarely be exceeded. Iron is a desirable constituent in aluminium bronzes; nowadays the most frequently used alloys of the aluminium-bronze series invariably contain low percentages of this element—say 1 to 4 per cent. of iron associated with 7 to 10 per cent. of aluminium. For small sand castings, copper 89, aluminium 10, iron 1, is representative of good practice; for large sand castings the iron may be increased to 4 per cent. at the expense of either the copper alone, or the copper and aluminium. It is not advisable to exceed the percentage of iron stated except for very occasional work.

Defective Castings.

Dross, shrinkage and gas cavities, and isolated patches rich in aluminium-oxide, are common findings in defective castings, and the occurrence of these undesirable features, even when every precaution was thought to have been taken, has caused many disappointments, and it is for this reason, coupled with the necessarily extravagant use of metal, that an order for castings in aluminium bronze is not welcomed by many foundrymen. It is only by the strictest attention to details throughout the making of the metal, the moulding of the part, and the teeming of the alloy, that one may expect even a fair measure of encouraging success. Comparatively few castings of aluminium bronze other than die castings are in service to-day, the inherent difficulties presenting themselves during the manufacture of sand castings having caused this metal to be somewhat out of favour.

Copious notes and hints as to the compounding and casting procedure to be followed in the manufacture of aluminium-bronze castings brought the lecture to a conclusion.

* A lecture given to the Wales and Monmouth Branch of the Institute of British Foundrymen, at Weston-super-mare, on Saturday, October 20, 1928, Mr. R. G. Williams presiding.

DISCUSSION.

In the discussion which followed, Mr. S. H. Russell (the President of the Institute) stated it was the first time he had heard Mr. Lambert, and he congratulated him on the wonderful amount of information given to the meeting. How was the zinc and tin preheated, and was there any real efficiency in preheating the metals? The hot pot was a very good tip. He related how, when using a tin-copper alloy with 13.4 per cent. tin—subject to a Brinell test—for small bush castings, the requisite hardness was not obtained. Was it the rate of cooling which influenced the hardness? With the same metal in a larger casting the required test was invariably obtained.

Referring to the crystal grain and the structure of gunmetal, Mr. Russell said that his firm, during the war, had cast wheels 12 lbs. in weight, 7 in. in dia., and 3 in. in thickness. These were subsequently machined, and the first wheel of the batch which the Inspector held up to the light could be seen through. This fault was overcome by casting in circular iron chill moulds.

In reply, Mr. Lambert said that with a 13 per cent. tin content, there should be a Brinell hardness of from 95 to 110; the initial casting temperature and the subsequent rate of cooling being the determining factors governing the hardness of the particular alloy cited. Referring to preheating, Mr. Lambert said that the constituent metals were warmed up on the flues.

Mr. Hird said that when using aluminium-bronze he had always added the iron in wire form after putting in the aluminium. He had the idea that the chemical action of the copper and aluminium accelerated the melting of the iron.

Mr. Lambert said that the fact that iron had a high melting point had little to do with its alloying properties. Nickel has a high melting point but will dissolve in molten tin at a comparatively low temperature.

Mr. Longden asked whether it was essential to use plumbago or copper stirrers, and also whether it was advisable to ingot all swarf and borings? Did the ingoting get rid of the gas? Molten gunmetal, if incorrectly treated, became gassed. He would like to hear of some way of getting rid of the gases.

Mr. Lambert, in reply, stated that it was almost impossible to melt swarf without the metal becoming gassed to a certain extent. When run into ingot, however, and remelted, it was possible to rid the metal of most of the occluded gases. In reconditioning the metal, the introduction of 0.05 to 0.10 per cent. of phosphorus would have a very beneficial effect on the metal. Plumbago or copper stirrers, although not essential, were recommended to ensure a low iron content in the alloy.

Mr. Hird asked, was it a good thing first to melt an aluminium-alloy and then to allow it to cool down and again re-heat before casting, to secure a closer grain. He mentioned this, because he had recently visited the University College at Cardiff, where they were experimenting with aluminium-manganese alloys, and he had been informed that this method had proved successful.

Mr. Lambert replied that he personally did not have recourse to this practice.

Mr. Wayman asked whether it was always possible to have a splash sump at the bottom of a runner. Could this be done with tailshaft liners?

Mr. Lambert said that the introduction of a splash sump was sometimes impracticable, but he advocated the use of a sump whenever possible.

Mr. Wayman said that he would like to relate an experience. When using a high tin mixture (82 and 18 per cent.) for heavy bearings, at a time when his pyrometer was out of gear, the castings had not long been made before segregation of the metal commenced, as evidenced by some portion of the alloy sweating out. Had the cause of this been too high a temperature?

Mr. Lambert said that Mr. Wayman referred to what was commonly known as "tin sweating." Analysis would show this exudation to be a compound of copper-tin having a much lower melting point than the matrix in which it was present. It was forced out by the contraction stresses accompanying the solidification of the casting. Attention to the casting temperature would help to remove this trouble.

Referring to tailshaft castings, Mr. Lambert asked whether Mr. Wayman's practice was to cast vertically, and was informed that this was the case. Mr. Lambert said that in some foundries such liners are cast flat, and in others vertically, making use of a fin runner throughout the whole length of the casting, thus ensuring hot metal at the top during the running of the casting.

Mr. Gardom asked, did phosphorus serve a useful purpose other than as a deoxidiser?

Mr. Lambert replied that phosphorus was a very active deoxidiser, and its use in small quantity was often advisable; but the object of adding phosphorus, as in the case of the true phosphor bronzes, was to ensure physical and mechanical properties inherent to those alloys, properties largely due to the formation of a microstructure peculiar to such bronzes, which fitted these alloys to serve as bearing metals, etc.

Mr. Gardom also inquired as to the melting loss likely to occur in the case of Admiralty gunmetal.

Mr. Lambert stated that the zinc content might be reduced to 1½ per cent.

Mr. Gardom then inquired whether it was possible to melt bronze in an induction melting furnace.

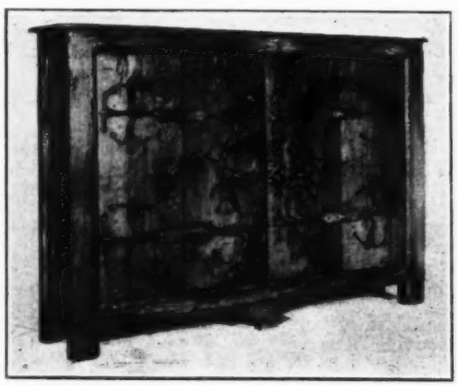
Mr. Lambert said he had had no personal experience in the connection, but he should not consider it an economic proposition except perhaps in the case of some nickel-copper alloys.

The Abbot's Cupboard.

By H. Littlehales.

Very often, when reading the history of an old abbey, the thought has come to the reader of how interesting it would be to see a piece of the old domestic furniture of such an establishment, the more particularly if such a piece retained its metal fittings.

Though few such articles still exist, one fine piece of such monastic furniture does remain, and science by photography has made it possible for a reader sitting before the fire to see every line of it as though it were before him.



The Abbot's Cupboard.

The article in question is a cupboard once in use in the abbey of Whalley, in Lancashire, and very probably at one time containing personal belongings of the abbot. This fine cupboard shows us the form of such articles in the 14th century, and to what extent a number of them were dependent on wrought iron for their construction. Little need be said as to the design of the ironwork, which is both interesting and unusual for any period. It follows the usual method in its support of the frame and doors. The photograph shows the grain of the oak, which probably came from a tree grown in the north country in the 14th century. There seems to be a pronounced shake in the timber near the top left-hand corner.

This cupboard was a gift to the Victoria and Albert Museum by the National Art Collections Fund. Our picture is kindly supplied by the Director of the Museum.

Book Reviews.

Die metallurgischen und metallographischen Grundlagen des Gusseisens. By K. von Kerpely. Halle (Saale): Wilhelm Knapp.

This little brochure forms Part 7 of a series entitled "Die Betriebpraxis der Eisen-Stahl-und Metallgiesserei" (Iron, Steel and Metal Foundry Practice), edited by Hubert Hermanns, the author of the present part being K. von Kerpely. Its aim is to place before the reader brief *résumés* of recent important contributions to periodical literature on the subject of cast iron by various writers and the results of some of the author's own investigations. The seven chapters into which the text is divided deal respectively with (1) the structure of cast iron; (2) the influence of Si, Mn, P and S on the structural properties of cast iron; (3) the forms of graphite dependent on the rate of cooling and their influence on the structure of cast iron; (4) the influence of some elements on the structural properties of the iron; (5) mechanical properties depending on structure and treatment; (6) the shrinking of cast iron; and (7) the growth of cast iron under repeated heating and cooling. The author almost invariably gives chapter and verse for his statements, and invites criticism in case opinions expressed by himself should not meet with the reader's approval. His own conclusions are principally derived from experience gained with superheated cast iron, more especially in the electric furnace, with which branch he himself is connected. There are 135 illustrations and 34 tables.

Enamels; Their Manufacture and Application of Iron and Steel Ware. By Laurence R. Mernagh, B.Sc., F.I.C. Published by Griffin & Co., Ltd., 42, Drury Lane, W.C.2. Pp. ix-234, illustrated. Price 18s.

In his preface the author tells how the enamelling of iron ware came to England from Germany, and rose to importance during the war, falling away again as soon as it met the blast of foreign competition. He is very scathing on the attitude of English makers towards scientific progress, comparing them unfavourably with the Germans and Americans. The "Safeguarding" duty of 25 per cent. is regarded as being the salvation of the industry.

Having given a detailed description of the preparation of the blanks—the pickling, washing and inspection, he describes the general properties of enamels, and of the raw materials used in their manufacture, with especial reference to those adapted for the production of opacity. A chapter is devoted to the subject of suitable clays for retaining the ground frit in suspension, and another to tin oxide and its substitutes.

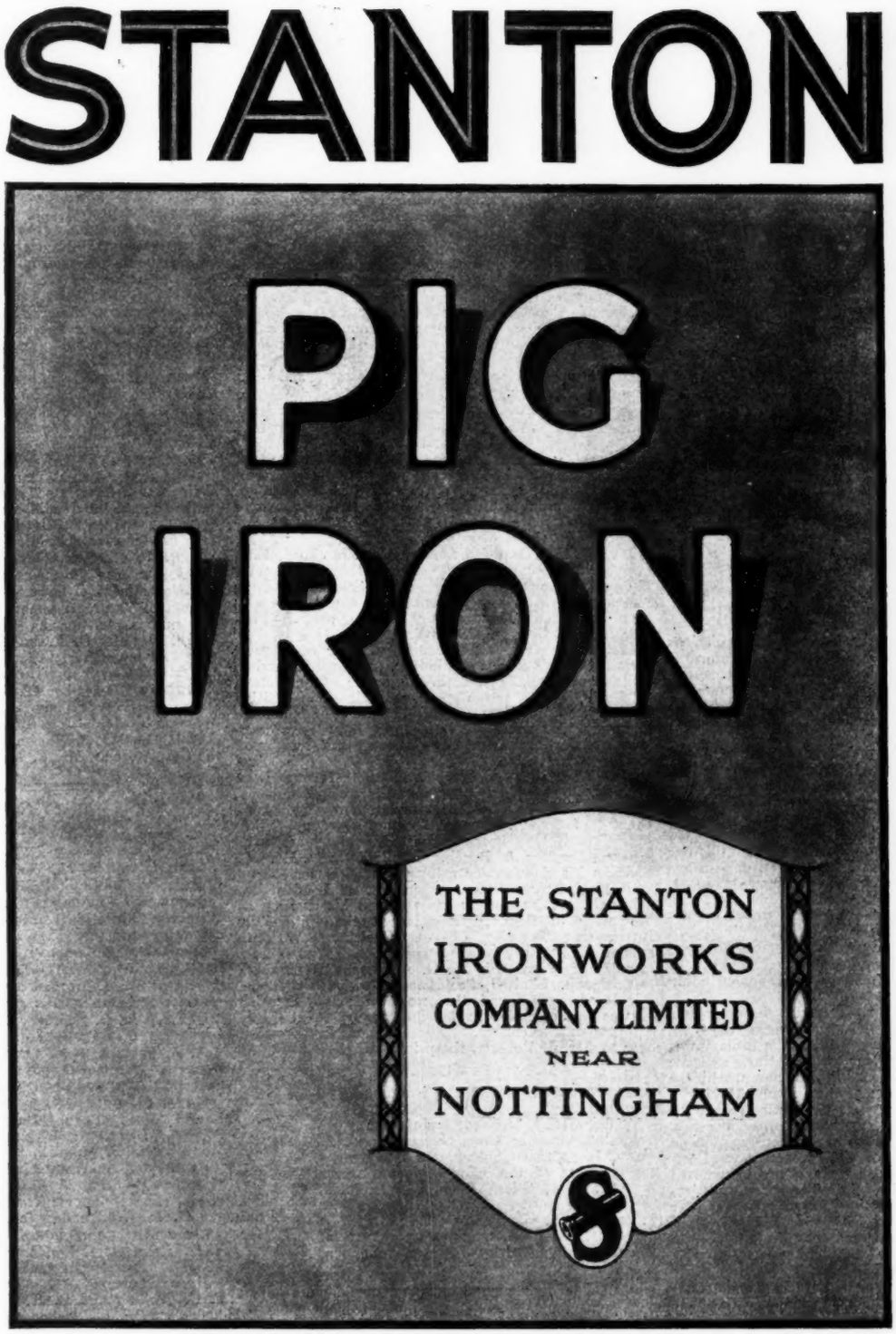
In calculating the formulæ for batches of enamels, the author appears to advocate a very complicated molecular method of recording the analytical results, but is not, apparently, that usually adopted, which seems to be either straight percentages or pounds per batch. The metric system is not advised.

The physical properties of enamels, their preparation and application, are described adequately, as also are the materials for coloured enamels, though oddly enough there is no mention of suitable substances for the production of a black—a very popular colour, and one not easy to obtain. From the context it appears that a paragraph has been omitted in the setting up of the type, there being an allusion to "ingredients mentioned," though none is mentioned.

The test of the stability of an enamel is to expose it for two years on a factory roof; the enamelling industry is one of the few in which such a test could be carried out; most would need a somewhat shorter test.

Foundry details for the making of cast iron are given, and in speaking of the factory layout the question as to whether it is better to make or to buy the blanks is discussed quite fully and inconclusively. The book is supplied with appendices giving conversion of degrees C. to F. and of centimetres to inches.

One might wish to join issue with Mr. Mernagh on the subject of dermatitis. The book is a very useful and interesting treatise on a little known subject.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

According to the "Canadian Foundryman," Mr. A. Aitken, a director of the Burton Foundry Company, is considering the establishment of a foundry concern in Canada.

Messrs. Harland & Wolff, Limited, of Belfast, have received an order to replace the double-reduction geared turbines of the Canadian Pacific liner "Montclare," 16,314 tons gross, with single-reduction geared turbines.

At an extraordinary general meeting of Ruths Steam Storage, Limited, held at the registered office of the company, a resolution authorising an increase of capital from £300,000 to £500,000 was confirmed.

Quiet conditions at present rule in the ship-repairing industry on Tyneside. Shipowners have entered upon a period of greater activity, and consequently are refraining from docking their vessels for survey, overhaul, or minor repairs wherever possible.

The Canadian Pacific Railway Company have placed an order for a liner of 40,000 tons with Messrs. John Brown & Company, Limited, of Clydebank. The vessel will be 750 ft. in length and 97 ft. in breadth, and will be propelled by steam turbines.

The Wheesoe Foundry & Engineering Company, Limited, of Darlington, have completed negotiations, in conjunction with two other British companies, for the sole manufacturing rights for Europe of the "Hortonsphere" gasometer, a new American invention.

The Vulcan Foundry, Limited, of Newton-le-Willows, Lancs, have received orders for 28 heavy-type passenger locomotives for India, 20 for the East Indian Railway and eight for the Bombay, Baroda and Central India Railway. They are of the 4-6-2 type, with double-bogie tenders.

Last Saturday week the members of the Ipswich Branch of the Association of Engineering and Shipbuilding Draughtsmen visited the Suffolk Ironfoundry (1920), Limited, Stowmarket. The design of this particular plant won the first prize in a fifty-guinea competition which we organised some eight years ago.

The annual meeting of the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain was held recently in Manchester, Mr. Samuel Bamber (vice-president), of Blackburn, presiding. Mr. Ashley S. Ward, joint managing director of Messrs. Thos. W. Ward, Limited, Sheffield, was re-elected president.

The Grinding and Pulverising Offices of International Combustion, Limited, 11, Southampton Row, London, W.C.1, report that orders have recently been received for the following equipment:—For England: One five-roller Raymond mill, for grinding oxide; one 3-ft. by 8-in. Hardinge ball mill, for grinding roasted material; one 3-ft. by 8-in. Hardinge ball mill, for grinding copper oxide; eight 3-ft. by 5-ft. one-surface electric screens, for screening cement slurry; one 4-ft. one-surface electric screen; and one 3-ft. by 5-ft. one-surface electric screen, for screening starch cream. For Australia: Two 4½-ft. by 16-in. Hardinge ball mills, for grinding lead-zinc concentrates. For France: One four-roller Raymond mill, for grinding steatite; and one 8-ft. by 60-in. Hardinge mill, for grinding anthracite.

Messrs. Broom & Wade, Limited, air-compressor manufacturers, have removed their works at High Wycombe to an entirely new site in the same town, where they now occupy a floor area six times as large as at their original works. Additional new machinery has been installed. A feature of this big undertaking is the fact that all machinery was dismantled, removed, and re-erected in the new shops within a period of six days, and practically normal production was being obtained on the morning of the seventh day. Portable and in-bye air-compressing plants are being used in increasing numbers in mining practice, particularly for development work and operating pneumatic picks, and Messrs. Broom & Wade, Limited, have made a bid to develop this market. In addition to manufacturing a complete range of portables with capacities of from 25 to 260 cub. ft. per min., the demand for their stationary sets, both belt and steam-driven, is increasing. These are made in a complete range of sizes up to 1,200 cub. ft. per min.

The Industrial Health Education Society is carrying out a large and growing programme of health talks to workers in all trades and industries. The workers' organisations are co-operating financially, and it is hoped that employers and their organisations will respond to the occasion and show their practical interest in this work. That this kind of propaganda is much needed is indicated by the 1927 report of Sir George Newman, which shows that in 1927 no less than £11,726,000 was spent on sickness benefit and £6,356,000 on disablement benefit. Add to that roughly £9,536,000 (the 1926 figure) for medical benefit, and it will be seen that the very large amount of £27,618,000 was spent on sickness, disease and disablement, 50 per cent. of which doctors say was avoidable had the workers had and used the available information. It means that in England and Wales there was lost to the nation in one year, among insured workers only, a total of 30½ million weeks' work, or the equivalent of 12 months' work of nearly 590,000 persons.

With an authorised capital of £100,000 divided into 1,000,000 2s. shares, the Coventry Gauge & Tool Company (1928), Limited, invited subscriptions recently to 730,000 of these shares at par. The business has been carried on as a private enterprise since 1913, and the present company has been formed to acquire, as from July 31 last, and as a going concern, the factory and buildings for the manufacture of jigs, gauges, special machinery and tool equipments, etc. The net proceeds of the issue amount to about £32,250, considered as ample for additional working capital after covering the cost of proposed extensions to factory and plant. Including this sum, but excluding goodwill, the net assets total £88,955. The purchase price is £52,000, of which £25,000 is in cash and the balance by allotment to the vendor company of 270,000 shares. A programme of development is in view. The directors of the company are the Hon. Schomberg C. Trefusis (chairman), Mr. Herbert H. Harley (managing director), and Mr. Stanley J. Harley.

Personal.

Mr. Edward G. Acheson has presented a trust fund of $25,000 to the American Electrochemical Society to provide an award, every two years, of a gold medal and a prize of $1,000 for important contributions to the Society's proceedings.

Mr. W. A. Logan, of Sunnybank, Kingshorn, Fife, has been appointed agent of the British Schaefer Company, Limited, for the whole of Scotland and the North-East Coast of England. Mr. Logan has also been appointed to represent Messrs. Nortons (Tividale), Limited, on the North-East Coast.

Mr. James Oswald, managing director of Messrs. James Oswald & Sons, Limited, Sleaford Foundry, Nine Elms Lane, London, S.W.8, and a past-chairman of the London Section of the Institute of British Foundrymen, has been elected Master of the Plumbers Company. On behalf of the foundry industry we congratulate Mr. Oswald on the honour conferred upon him.

Mr. J. Smart and Mr. C. Harman Harris have been appointed joint managing directors of Messrs. Bradley & Burch, Limited, tinplate and metal merchants, of 5, Whittington Avenue, London, E.C.3. Mr. Smart has been connected many years with Messrs Bradley & Burch, Limited, and Mr. C. Harman Harris was for many years with the Sturtevant Engineering Company, Limited, of London.

Mr. F. W. Nicholson has resigned his position as Instructor in Foundry Practice at the Automobile Engineering Training College, Chelsea, S.W.3, to assume the position as manager of the new brass foundry of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Scotswood, Newcastle-on-Tyne. His departure was made the occasion for a presentation of a cabinet of cutlery, subscribed for by the staff and students of the college. The function was presided over by Mr. J. Roberts, the principal.

Wills.

Greenwood, W., of Lytham, ironfounder ...	£30,348
Hurll, M., chairman of Messrs. Peter & Mark Hurll, Limited, firebrick and gas-retort manufacturers, Glasgow	£64,483
Ford, D., of Birmingham, for many years manager of the King's Norton works of Messrs. Guest, Keen & Nettlefolds, Limited	£19,203
Still, W. C., of Messrs. W. M. Still & Sons, Limited, engineers and metal spinners, Charles Street, London, E.C.1	£32,855

Obituary.

Mr. H. E. Garratt, of Messrs. Garratt & Company, Limited, fire-brick manufacturers, Cradley Heath, died recently.

Mr. Joseph Hardill, of Messrs. Wm. Hardill, Sons & Company, Limited, engineers and ironfounders, died recently at the age of 77 years. Mr. Hardill started in business as an ironfounder in Cleckheaton 53 years ago, and later was joined by his father and brothers, when the firm of William Hardill, Sons & Company came into being.

Contracts Open.

Alton, November 23.—Pumping machinery, for the Urban District Council. Messrs. H. Rofe & Son, 208, Abbey House, Victoria Street, Westminster, S.W.1. (Fee £5 5s., returnable.)

Christchurch, N.Z., November 24.—Pumps, etc., for the City Council. The Department of Overseas Trade. (Reference A.X. 7006.)

Congleton, November 19.—Pipes and specials, for the Corporation. Mr. W. H. Duncan Arthur, Town Hall, Congleton.

Dublin, November 26.—1¾ miles of cast-iron sewers, etc., for the Borough Commissioners. The City Engineer, 28, Castle Street. (Fee £5, returnable.)

Halifax, November 19.—1,300 tons of cast-iron pipes, etc., for the Town Council. Messrs. G. H. Hill & Sons (Manchester), civil engineers, 40, Kennedy Street, Manchester. (Fee £1 1s., returnable.)

Johannesburg, November 17. — One electrically-driven pump and motor, etc., for the Town Council. The Department of Overseas Trade. (Reference A.X. 7055.)

Johannesburg, December 6.—One 5-ton Diesel-electric crane, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7015.)

Johannesburg, December 6.—Five electrically-driven traversers and one 5-ton hand-operated overhead travelling crane, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7023.)

London, S.E., November 9-16.—(1) 20 tons of antimony; (2) eight multitubular boilers; (3) 14 bogies for rolling stock; and (4) 170 tons of galvanised corrugated mild-steel sheets, for the India Store Department, Belvedere Road, Lambeth, S.E.1. (Fee 5s. for each schedule, non-returnable.)

Lourenco Marques, November 24.—Iron and copper stores, for the Posts and Telegraphs Department. The Department of Overseas Trade.

Stoke-on-Trent, December 12.—Two steam engines, with pumps, etc., for the Staffordshire Potteries Water Board. Mr. R. C. Frain, engineer and general manager, Albion Street, Hanley, Stoke-on-Trent. (Fee £5, returnable.)

Uruguay, December 22.—Electric meters, for the State Electricity Supply Works. The Department of Overseas Trade. (Reference B.X. 4817.)

West Hartlepool, November 17.—Metal castings, for the Corporation. Mr. F. Durkin, Municipal Buildings.

New Companies.

Loxit, Limited, 1, New Square, Lincoln's Inn, London, W.C.—Capital £100. Ironfounders, etc.

Component Engineers, Limited, Hong Kong Works, Wembley Exhibition Estate.—Capital £500. Permanent managing director: H. Greenfield.

Star Welding Company, Limited, 38c, Peterborough Road, London, S.W.—Capital £2,500. Permanent directors: W. J. Morgan and W. J. Patience.

James Simpson & Son (Peterhead), Limited.—Capital £7,200 in 3s. shares. Agricultural engineers, etc. Directors: A. Davidson, J. Fowlie and J. Mackie.

A. A. Corre & Sons, Limited.—Capital £100. Metal spinners. Permanent governing director: Alfred A. Corre, 51, Chandos Road, Cricklewood, London, N.W.

Knowsley Cast Metal Company, Limited, 24-32, Lower Moss Lane, Hulme, Manchester.—Capital £10,000. Directors: J. Mundell (permanent), G. F. Mundell and F. Mundell.

Fanshaw & Shurmer, Limited, 5, Altrincham Street, Manchester.—Capital £1,000. Machinery manufacturers, etc. Directors: T. C. Woolfenden, T. Shurmer and G. M. Woolfenden (chairman).

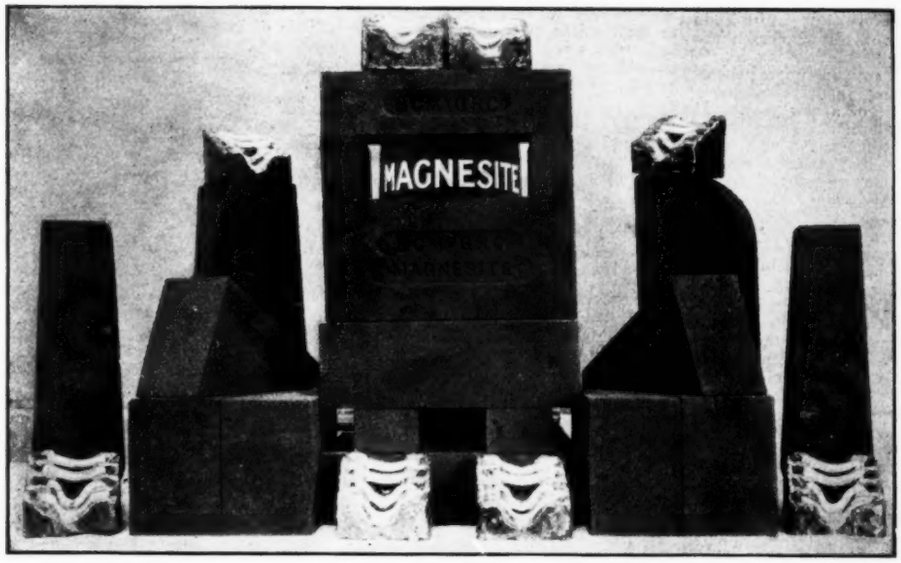
Grosvenor Construction Company, Limited, 56, Buckingham Gate, London, S.W.—Capital £10,000 in 5,000 7½ per cent. cumulative preference and 5,000 ordinary shares of £1. Engineers, etc. Directors: F. C. Cordery and E. H. Jones.

Ash Company (London), Limited, 21, Wigmore Street, London, W.—Capital £750 in 1s. shares. Manufacturers of power plant equipment, etc. Directors: P. B. Silk (chairman and managing director), F. B. Allen and L. P. Hoff.

Relative Engineering Company, Limited, 311, Cambridge Road, London, E.—Capital £4,000 in 1,500 8 per cent. participating preference, 1,000 ordinary and 1,500 deferred ordinary shares of £1. Directors: E. W. Vine, A. W. Tory (chairman), F. J. Humphrey (managing director) and G. A. Humphrey (managing director).

Established 1913.

BRITISH MADE MAGNESITE BRICKS, PERFECT IN SHAPE, HIGHLY REFRACTORY, EQUAL IN PRICE



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—yes, but in this case, usefulness and craftsmanship go hand in hand.

The perfection of shape and regularity of size of our

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MAGNESITE BRICKS

are due in large measure to

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The temperature is controlled by Holdcroft's Thermoscope Bars, sets of which are placed in each kiln. The even bending of the bars shown above, and which are taken from several kilns, illustrates the regularity of firing.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—As previously outlined in recent reports of the Cleveland iron trade, conditions vary little from week to week, and as the season advances anticipations of an autumn improvement, or more active market movement, appear less likely to materialise before the advent of a new year. It is now generally admitted that both home and export demands are equally disappointing in the volume of business transacted, and although limitation of furnace outputs has been carried out on a drastic scale, pig-iron production can hardly be claimed as a very profitable enterprise in the existing conditions of the industry. As indicating the present position of the export trade on Tees-side, it may be noted that the October shipments of pig-iron have shown a decline from 18,046 tons in September to 16,774 tons in October, the decrease being entirely restricted to the coastwise shipments. Notwithstanding the adverse circumstances with which they are faced, the Cleveland ironmasters still adhere to their fixed minimum prices, which are as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton. At these prices there is not much inducement to consumers to enter into forward contracts, and business is almost exclusively confined to small orders for prompt delivery.

In contrast to the depression in the foundry iron section, it is satisfactory to record continued improvement in the hematite trade, in which export business is fairly active, while Sheffield and South Wales are also taking good quantities on the basis of 70s. per ton for East Coast mixed numbers, and 70s. 6d. for No. 1 quality. On the North-West Coast prices are hardening, with Bessemer mixed numbers now quoted at 70s. 6d. per ton at works.

LANCASHIRE.—Buying in the local markets for foundry pig continues on the quiet side, with deliveries somewhat below the autumn average, prices, however, remaining at about the recently established levels. For delivery Manchester or equal distance Derbyshire No. 3 is quoted at 68s. to 68s. 6d. per ton, Staffordshire brands at 67s. 6d., Cleveland selling at 79s. per ton for local delivery, and Scottish at 87s. 6d. up to 90s.

THE MIDLANDS.—Prices of foundry pig at Birmingham during the current week have maintained previous firmness, with demand on local account about the usual average. In this market Derbyshire No. 3 is on offer at 60s. to 61s., Northants, equal quality 56s. 6d. to 58s., North Staffordshire 60s. to 61s., all per ton at furnaces. There are small tonnages of Scotch pig-irons used in certain classes of foundry work in the Midlands, and this iron, No. 3 grade, is on offer at between 89s. and 91s. per ton, delivered stations here.

SCOTLAND.—No improvement can as yet be reported in the position of the Scottish pig-iron industry, and prices remain unchanged at 70s. per ton at furnaces. Many of the Scottish foundries are only able to operate for a part of each week; in consequence their pig-iron requirements are considerably curtailed, and they are unable to take out within contract time the material they have already bought.

Finished Iron.

The manufacturing departments of the trade, both in South Staffordshire and elsewhere, continue to be quiet, and inquiries are still on the slow side, with prices practically unchanged. Makers of marked bars of approved brands still maintain quotations at £12 per ton, with crown quality from £9 per ton, with 10s. extra for Staffordshire brands, and nut and bolt iron from £8 15s. to £9 per ton, British make.

Steel.

A fair volume of orders and inquiries for constructional and other qualities of steel is in circulation at present and the outlook for the home trade generally is more satisfactory than for some time past. In semi-finished steel the improved conditions which were established are maintained. Foreign semis are not obtainable on attractive terms and British works are either making their own billets and sheet bars or buying them from home producers. Continental material is still probably a little cheaper than British, but the extended times of delivery which are stipulated are more than sufficient to turn the scale in favour of the British product. Full order books for some time ahead are now held by a number of the home works. Business in the tinplate market has livened up a little of late and some quite good buying was reported on Continental and South American account. Prices paid were generally round 18s. per box f.o.t. Wales.

Scrap.

Demand for foundry scrap material in the various markets is still irregular. The Tees-side foundries are taking deliveries of ordinary heavy cast iron in limited quantities, and the price is unchanged at 60s. per ton, while machinery quality realises round about 65s. In the Midlands there is a fairly good inquiry for heavy cast-iron scrap for use in the local foundries at from 62s. 6d. to 65s. delivered, according to quality. Light cast-iron scrap is firm at 55s. delivered. In Scotland it is now difficult to obtain even 65s. for machinery cast-iron scrap suitable for foundries, as there are few buyers. Ordinary heavy cast-iron scrap is at 60s. to 61s., old cast-iron railway chairs are unchanged at 64s. to 65s., light cast-iron scrap at 57s. 6d., and old cast-iron firebars at 55s. These prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The steadily progressive advance in warrant copper values has been checked, and prices are now sagging a little. Nevertheless, last week's closing price was the highest level since 1925. Now that production is completely controlled and demand is steadily increasing, the substantial advances are not surprising; there has been a tendency in this direction for some time, and the general stiffening of values was not altogether unexpected.

Closing quotations are:—

Cash.—Thursday, £68 2s. 6d. to £68 3s. 9d.; Friday, £67 17s. 6d. to £57 18s. 9d.; Monday, £67 8s. 9d. to £67 10s.; Tuesday, £67 11s. 3d. to £67 12s. 6d.; Wednesday, £67 10s. to £67 11s. 3d.

Three Months.—Thursday, £68 11s. 3d. to £68 12s. 6d.; Friday, £68 7s. 6d. to £68 8s. 9d.; Monday, £68 to £68 1s. 3d.; Tuesday, £68 1s. 3d. to £68 2s. 6d.; Wednesday, £68 to £68 1s. 3d.

Tin.—After a period of irregularity the market for standard cash tin appears to be settling down to steadier conditions, and quotations show a substantial advance on the week. It is, however, fairly obvious that the consumption of tin is expanding, but it does not yet keep pace with the ever-increasing flow of supplies.

Official closing prices:—

Cash.—Thursday, £230 7s. 6d. to £230 10s.; Friday, £231 to £231 5s.; Monday, £229 7s. 6d. to £229 10s.; Tuesday, £230 7s. 6d. to £230 10s.; Wednesday, £231 10s. to £231 12s. 6d.

Three Months.—Thursday, £224 to £224 5s.; Friday, £224 10s. to £224 15s.; Monday, £221 15s. to £221 17s. 6d.; Tuesday, £222 5s. to £222 7s. 6d.; Wednesday, £224 7s. 6d. to £224 10s.

Spelter.—The market for ordinary spelter continues lacking in interest but prices are moving within narrow limits, and, although some grades are in fairly good demand, buyers are not at all active. Users appear to have covered themselves by contracts in many cases, and, as things are at the moment, there is no indication of a revival of activity in this market for some time to come.

Daily quotations are:—

Ordinary.—Thursday, £23 16s. 3d.; Friday, £23 17s. 6d.; Monday, £24 2s. 6d.; Tuesday, £24 5s.; Wednesday, £24 3s. 9d.

Lead.—In the market for soft foreign pig, demand is on the slow side; shipments are not heavy and will not be so until lead held up by the strike in Australia begins to arrive. It is thought likely that the September figures will be an improvement on those for August, and, as present and immediate business is good, the prospects for the remaining months of this year are full of hope.

Soft Foreign Prompt.—Thursday, £22; Friday, £21 15s.; Monday, £21 8s. 9d.; Tuesday, £21 8s. 9d.; Wednesday, £21 6s. 3d.

Sheffield Patternmaking and Costing.

Mr. J. Booth, in a recent lecture to the Foundry Society, referred to the mistaken notion of regarding patternmaking as an expensive cost in the production of castings. The familiar criticism that patterns were too costly should be examined and all the factors governing the cost of the casting taken into consideration. In the first place a good pattern is the first essential step towards a good casting. The money spent on the pattern will be more than saved in the foundry, especially when it is remembered that the less tooling the mould had the better would be the casting.

In machine moulding the maximum amount of work was done by the patternmaker and the minimum by the moulder. This principle applied in hand moulding, and patterns should be regarded from the same point of view. In making up, and especially in green sand, it would be found that efficiency in pattern work would produce satisfactory results in the foundry.

The only patternmaking, in his opinion, which could be regarded as expensive was the "cheap" pattern. The attempts to save money in the patternshop by reducing the work and causing more work to be done in the mould was both expensive and inefficient. Finally, it should be remembered that the introduction of efficient machinery into the patternshops had enabled the patternmaker to increase his output considerably, and to reduce the costs of the individual pattern and core-boxes.

In some cases, such as skeleton work and bedded-in work, much of the cost of patternmaking could be avoided, and this, in some cases, was an advantage.

DISCUSSION.

MR. J. EMMOTT presided, and in an interesting discussion it was pointed out that the modern tendency towards the elimination of competition among firms by amalgamation was a good step in the right direction because of the reduction in the number of different designs and patterns.

In the electrical trade, for example, such an amalgamation resulted in the reduction of sets of patterns, and better types of patterns could be produced because of the permanent work. In some cases of extreme competition, firms produced special patterns, which tended to duplicate the work and add unnecessarily to the cost of the patterns.

Whilst patterns might be regarded as expensive necessities in some cases, drawings should be considered, not from the point of view of their first cost, but of their ultimate use to the patternmaking, foundry, and engineering shops. The practice of altering figures on drawings and also of using one hand drawing for the reverse hand instead of making a new drawing, was a bad one. When alterations were required to be made, either complete new drawings should be issued or the alterations, if only slight, might be carried out clearly on all the drawings, tracings, and prints.

Volume Changes in Cast Iron.

We note with pleasure that Dr. Donaldson's Paper on the "Heat Treatment and Volume Changes of Grey Cast Iron between 15 and 600 deg. C.," which was presented on behalf of the Institute of British Foundrymen to the Association Technique de Fonderie at the recent annual general meeting, was the subject of a lively discussion.

The Paper was presented by Mr. Delpot, and Mr. Ronceray announced that the translation had been made by Mr. F. Renaud, which latter expressed the hope that Dr. Donaldson would continue his researches as to the influence of sulphur on graphitisation. Professor Rabozé (Belgium), Messieurs Le Thomas, Mathieu Varlet (Liége), Fournel Ropsy (President of the Belgian Foundry Associations), and Ramas (past-President, A.T.F.) took part in the discussion, which was both extensive and animated and showed clearly the interest which is being taken universally in the question of volume changes.

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The Key to Better Castings*

Capponfield

Hot "H.B." Blast

*THE blowing-in of the Capponfield Blast Furnaces meets the demand for a good class brand of South Staffordshire Foundry Iron, produced under carefully controlled conditions to comply with modern foundry requirements.

BRADLEY'S Capponfield Hot Blast is an excellent grade of iron, supplied with low phosphorus, low sulphur and medium manganese contents. The silicon content is supplied to suit the specific requirements of each customer, and a complete analysis of each cast is available. The addition of Capponfield Iron to your mixture is highly desirable for the production of good class engineering and general castings at competitive prices. Capponfield "H.B." means Strength plus Easy Machining.

3 Perfect Grades

Capponfield H.B.
(HOT BLAST)

Capponfield W.B.
(WARM BLAST)

Capponfield C.B.
(COLD BLAST)

Bradley's CAPPONFIELD
PIG IRON

"Capponfield Quality"

All Capponfield Irons are direct blast furnace products. Bradley's well-known Refined Irons are made at the Darlaston Works.

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(All communications should be addressed to Darlaston).

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WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	67 10 0
Three months	68 0 0
Electrolytic	74 15 0
Tough	71 10 0
Best selected	72 0 0
Sheets	98 0 0
India	80 0 0
Wire bars	75 0 0
Do. November	75 0 0
Do. December	75 0 0
Ingot bars	75 0 0
H.C. Wire rods	79 0 0
Off. av. cash, October	65 11 4 7/23
Do. 3 mths., October	66 0 5 5/23
Do., Sttlmnt. October	65 11 2 9/23
Do., Electro, October	72 3 5 13/23
Do., B.S., October	66 11 4 4/23
Aver. spot price, copper, Oct.	—
Do., Wire bars, October	72 8 3 5/23
Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10½d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11¾d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10½d
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	231 10 0
Three months	224 7 6
English	229 0 0
Bars	228 0 0
Straits	231 10 0
Australian	231 10 0
Eastern	223 0 0
Banca	231 10 0
Off. av. cash, October	222 2 1 15/23
Do., 3 mths., October	219 18 5 7/23
Do., Sttlmt., October	222 1 7 9/23
Aver. spot, October	—

SPELTER.

	£ s. d.
Ordinary	24 3 9
Remelted	22 10 0
Hard	19 5 0
Electro 99.9	27 15 0
English	24 12 6
India	20 5 0
Zinc dust (Nom.)	35 5 0
Zinc ashes	7 15 0
Off. aver., October	24 0 7 1/23
Aver., spot, October	—

LEAD.

	£ s. d.
Soft foreign ppt.	21 6 3
English	23 15 0
Off. average, October	22 1 6 6/23
Average spot, October	—

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	33 0 0
Do. V.M. ex whf.	31 5 0
Rods	39 0 0
Boiler plates	29 0 0
Battery plates	30 10 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	57 10 0
Chinese	39 10 0
Crude	33 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	23 0 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£12 0 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/7½ to 1/8 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 2 6
6/8% car.	£20 0 0
8/10% car.	£20 0 0
Ferro-chrome—	
Max. 2% car.	£32 10 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£42 0 0
70% carbonless	1/- lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£98 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loss	£13 15 0
76/80% packed	£14 15 0
76/80% export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ¼ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 8 0	
Bundled steel and shrngs.	3 2 6	to 3 6 6
Mixed iron and steel	3 0 0	to 3 2 6
Heavy cast iron	2 16 0	to 2 18 0
Good machinery for foundries	3 0 0	
Cleveland—		
Heavy steel	2 15 0	
Steel turnings	2 8 0	
Cast iron borings	2 2 6	
Heavy forge	3 7 6	
Bushelled scrap	2 18 6	
Cast-iron scrap	3 2 6	
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 5 0	
Steel turnings	2 6 0	

London—Merchants' buying prices delivered yard.

Copper (clean)	£4 0 0
Brass	£9 0 0
Lead (less usual draft)	£9 15 0
Tea lead	£6 15 0
Zinc	£5 10 0
New aluminium cuttings	£2 0 0
Braziery copper	£0 0 0
Gunmetal	£0 0 0
Hollow pewter	£50 0 0
Shaped black pewter	£05 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	70/6
Hematite M/Nos.	70/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/0
,, fdry. No. 3	56/6
Derbyshire forge	59/-
,, fdry. No. 3	60/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	65/-
Lincs. forge	63/-
,, fdry. No. 3	64/6
E.C. hematite	81/-
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	58/6
Foundry No. 3	60/-
Basic	59/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	68/6
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 5 0
Nut and bolt iron	8 15 0	to 9 0 0
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ½ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.		10 10 0
Chequer plts.		10 12 6
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		8 17 6
Rounds under 3 in. to ½ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1½ in.		7 17 6
Rails, heavy		8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.	10 0 0	to 10 10 0
Galv.cor.shts.,24g.	13 10 0	to 13 15 0
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	6 5 0	to 6 10 0
Billets, hard	7 2 6	to 7 12 6
Sheet bars		6 0 0
Tin bars		6 0 0

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2¾
Sheet to 10 w.g.	1 3½
Wire	1 4½
Rods	1 3½
Tubes	1 7¾
Castings	1 2¼

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.70
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	16.26
Basic	18.70
Bessemer	19.26
Malleable	19.26
Grey forge	18.?0
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/3
Midlands, foundry	—
,, ,, furnace	13/6 to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/- to 18/3
,,	28×20 ,,	36/-
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	14/9
,,	28×20 ,,	33/6
,,	20×10 ,,	21/-
,,	18¾×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered,	£17 10 0 to £18 10 0
Bars & nailrods, rolled	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Nov. 1 ..	68 2 6	inc.	15/-
„ 2 ..	67 17 6	dec.	5/-
„ 5 ..	67 8 9	„	8/9
„ 6 ..	67 11 3	inc.	2/6
„ 7 ..	67 10 0	dec.	1/3

Electrolytic Copper.

		£ s. d.		
Nov. 1 ..	74 15 0	No change		
„ 2 ..	74 15 0	„	„	
„ 5 ..	74 10 0	dec.	5/-	
„ 6 ..	74 10 0	No change		
„ 7 ..	74 15 0	inc.	5/-	

Standard Tin (cash).

		£ s. d.		
Nov. 1 ..	230 7 6	inc.	62/6	
„ 2 ..	231 0 0	„	12/6	
„ 5 ..	229 7 6	dec.	32/6	
„ 6 ..	230 7 6	inc.	20/-	
„ 7 ..	231 10 0	„	22/6	

Tin (English ingots).

		£ s. d.		
Nov. 1 ..	227 5 0	inc.	15/-	
„ 2 ..	227 10 0	„	5/-	
„ 5 ..	225 10 0	dec.	40/-	
„ 6 ..	226 0 0	inc.	10/-	
„ 7 ..	229 0 0	„	60/-	

Zinc Sheets (English).

		£ s. d.		
Nov. 1 ..	33 0 0	No change		
„ 2 ..	33 0 0	„	„	
„ 5 ..	33 0 0	„	„	
„ 6 ..	33 0 0	„	„	
„ 7 ..	33 0 0	„	„	

Spelter (ordinary).

		£ s. d.		
Nov. 1 ..	23 16 3	dec.	5/-	
„ 2 ..	23 17 6	inc.	1/3	
„ 5 ..	24 2 6	„	5/-	
„ 6 ..	24 5 0	„	2/6	
„ 7 ..	24 3 9	dec.	1/3	

Lead (English).

		£ s. d.		
Nov. 1 ..	23 5 0	dec.	5/-	
„ 2 ..	23 5 0	No change		
„ 5 ..	22 15 0	dec.	10/-	
„ 6 ..	22 15 0	No change		
„ 7 ..	23 15 0	inc.	20/-	

AVERAGE MONTHLY PRICES OF IRON HOOPS.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 5 0	6 10 0	6 3 4
1897	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0
1898	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	8 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	7 0 0	6 11 8
1899	7 0 0	7 0 0	7 0 0	7 0 0	7 12 6	10 12 6	8 12 6	8 12 6	8 12 6	9 2 6	9 7 6	9 17 6	8 2 6
1900	9 17 6	10 7 6	10 7 6	10 7 0	10 12 6	7 12 6	10 12 6	10 12 6	10 12 6	9 17 6	9 2 6	9 2 6	10 3 9
1901	9 2 6	8 2 6	8 2 6	7 12 6	7 12 6	7 12 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 11 8
1902	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1903	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1904	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6
1905	6 17 6	7 0 0	7 0 0	7 0 6	7 0 0	7 0 0	7 2 6	7 2 6	7 2 6	7 7 6	7 0 0	7 7 6	7 2 6
1906	7 10 0	7 17 6	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 7 6	7 15 10
1907	8 7 6	8 7 6	8 7 6	8 7 0	8 7 6	8 7 6	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 0 0	8 7 1
1908	8 0 0	7 10 0	7 10 0	7 10 6	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 6 8
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0
1910	7 1 10½	7 6 3	7 7 6	7 7 0	7 7 6	7 7 6	7 7 6	7 7 6	7 7 6	7 6 3	7 5 0	7 6	5½
1911	7 5 0	7 5 0	7 5 0	7 5 6	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 8 9	7 10 0	7 10 0	7 6 1½
1912	7 12 6	7 12 6	7 12 6	7 15 0	8 2 6	8 2 6	8 2 6	8 2 6	8 12 6	8 12 6	8 12 6	8 15 0	8 2 3½
1913	8 17 6	8 17 6	8 17 6	8 17 0	8 17 6	8 17 6	8 17 6	8 7 6	8 7 6	8 7 6	8 7 6	7 17 6	8 12 6
1914	7 17 6	7 17 6	7 17 6	7 13 9	7 12 6	7 12 6	7 12 6	9 2 6	9 2 6	9 2 6	9 2 6	9 2 6	8 6 4½
1915	9 3 6	9 18 1	10 7 6	10 16 6	10 17 6	13 2 6	13 2 6	13 2 6	13 7 6	14 2 6	15 2 6	15 18 6	12 10 1½
1916	17 2 6	17 2 6	17 2 6	17 6 3	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 7 6	17 6 1½
1917	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1918	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6	17 2 6
1919	17 2 6	17 2 6	17 2 6	17 2 6	24 6 3	24 6 3	24 6 3	25 9 0	26 7 6	26 7 6	26 7 6	26 17 4	22 14 9
1920	28 0 0	28 12 6	33 15 0	35 5 0	35 15 10	38 17 6	38 17 6	38 17 6	38 17 6	38 17 6	36 17 6	36 17 6	35 14 9
1921	29 1 3	23 5 0	21 12 6	20 0 0	20 0 0	20 0 0	17 5 0	15 0 0	14 4 0	13 15 0	13 10 0	12 18 0	17 5 10
1922	16 5 0	15 13 9	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	13 4 6½
1923	14 0 0	15 0 0	15 0 0	15 0 0	15 6 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 16 0	14 15 0	14 18 3½
1924	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 13 9	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 12 4½
1925	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1926	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	12 10 0	12 10 0	14 3 4
1928	12 10 0	12 7 6	12 0 0	11 13 6	11 15 0	11 12 6	11 10 0	11 10 0	11 10 0	—	—	—	—

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REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

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FOUNDRY FOREMAN, 35, seeks situation; practical experience plate, machine, loose pattern, and strickle work for machine tool, electrical and general engineers' work up to 30 tons; iron, brass and semi-steel to specifications.—Box 880, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

IRON MOULDER, age 32, desires change; 15 years' experience on light and heavy engineering work; present position charge hand; also conversant with technical foundry practice, including cupola practice.—Box 882, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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FOUNDRY FETTLER.—A vacancy exists in a modern foundry in the South of England for an alert and active man as Foreman of the fettling section; cast iron and non-ferrous work up to 20 tons; must be good disciplinarian and have had previous experience in an executive position.—Apply in confidence, stating full details of past experience, age and wages required, to Box 878, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ALUMINIUM DIE CASTINGS.—Assistant Foundry Manager required, able to control production of gravity die castings; must be experienced in the trade, capable organiser and able to handle a large number of men.—Apply by letter only, stating age, full details of experience and salary required, to MANAGING DIRECTOR, Birmingham Aluminium Casting (1903) Company, Limited, Dartmouth Road, Smethwick, Staffs.

ALUMINIUM FOUNDING.—The Council of the British Non-Ferrous Metals Research Association, having decided to extend the Association's researches in this field, is prepared to consider candidates for the post of investigator. Applicants should possess the requisite scientific training in addition to practical works experience, preferably in an Aluminium foundry, and should be qualified to carry out a works survey and a laboratory investigation into the causes and prevention of unsoundness in castings and ingots of aluminium and its alloys. Appointment in the first place for one year at a salary of £500 to £600 according to qualifications.—Applications should be addressed to THE DIRECTOR, British Non-Ferrous Metals Research Association, 71, Temple Row, Birmingham.

PATENTS AND TRADE MARKS.

THE owners of British Patent No. 249186 for Improvements in the production of steel, are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention, either by sale of the patent rights or by the grant of a licence or licences to manufacture on royalty.—Inquiries should be addressed to MESSRS. ABEL & IMRAY, 30, Southampton Buildings, London, W.C.2.

PATENTS AND TRADE MARKS.—*contd.*

INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

THE proprietor of British Patents Nos. 227,968 and 228,070 (Divisional), both dated November 27, 1923, relating to "Improvements in machines and methods for making foundry moulds and cores" and "Vents for moulders' flasks and core boxes," respectively, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patents and ensuring their practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

AGENCY.

FOUNDRY ENGINEER, with office East Midlands, is open for further Agencies; offers invited; confidential; good references; able to demonstrate.—Box 876, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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STEEL FOUNDRY CRANE LADLES.—One 6-ton capacity, with worm tilting gear; one 15-ton capacity for bottom pouring.—For further particulars, write Box 870, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

STEAM CONDENSER, about 7 ft. 6 in. long, 3 ft. dia., with 900 sq. ft. cooling surface, 620 tubes 6 ft. 10 in. long by ¾ in. dia., capable of condensing 10,000 lbs. steam per hour, complete with or without electrically motor-driven 13-in. x 10-in. EDWARDS' AIR PUMP.—For further particulars, write Box 866, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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No. 7A SUNDERLAND Gear Generating Machine, capacity 18 in. dia. x 9 in. wide, for spur and spiral gears.

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No. 14 NATCO Multiple Spindle Drilling Machine, arranged for 22 spindles.

Two LOCO. TYPE BOILERS, 11 ft. 6 in. long, barrel 2 ft. 8 in., reinsurable 170 lbs. pressure.

Two Vertical "Cochran" Boilers, 11 ft. 3 in. high x 5 ft. dia., reinsure 150 lbs. pressure.

2-ft. gauge 20-h.p. and 40-h.p. "SIMPLEX" PETROL LOCOMOTIVES, ready for immediate despatch.

30-cwt. "Cole's" STEAM TRAVELLING GANTRY CRANES, 50-ft. steel jib, 120 lbs. W.P., 8 ft. 6 in. gauge.

CATALOGUE (10,000 Lots) ON APPLICATION.

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MACHINERY.—*Continued.*

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ENGINEER'S HORIZONTAL PLANING MACHINE, one tool box, stroke 8 ft., will admit 3 ft. 3 in. wide x 3 ft. 6 in. high, belt driven. ONE DITTO, stroke 6 ft., will admit 33 in. x 28 in. high, one tool box, belt driven; both for sale cheap.—Write, Box 863, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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PURIC CUPOLA FLUX.—Now used by over 500 Foundries. Ask for special Puric Mailing Card, giving particulars. Send to-day for trial cwt. at 35s. per cwt., carriage paid.

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THE FOUNDRY CHEMISTS,
RETORT WORKS,
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MALLETS (RAW HIDE), new, large quantity surplus stock for disposal; 2 in. at 18s. a dozen, 1¾ in. at 15s. a dozen, 1½ in. at 12s. a dozen; gross lots assorted less 10 per cent.—WILCOX & COMPANY, 23, Great Hampton Street, Birmingham.

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WAX CORE VENTS.—Yellow and Black, in all sizes, 1/16 to 3/8 in. diam., always in stock. Cwt. lots quoted special low.

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GANISTER, best quality, for Cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton

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15 Ton Stevenson	£65
10 Ton EVANS	£42
8 Ton EVANS	£40
5 Ton EVANS	£36
3 Ton EVANS	£28
2 Ton EVANS	£24
1 Ton NEW enclosed gear	£19
½ Ton as new	£8

All have worm and bevel gear.

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